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(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Computer Controlled Lighting System with Distributed Control Resources

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(30) (US) 08/473,150 1995/06/07

(57) 6 Claims

Notice: This application is as filed and may therefore contain an incomplete specification.

ABSTRACT

A distributed control system for a lighting system, including: one or more control devices for entering parameter-controlling inputs according to a specified format, the parameter-controlling inputs directing the operation of the lighting system, the control devices including a data processor coupled to the parameter-controlling inputs and a memory coupled to the processor; one or more computing devices for storing, editing, and displaying data related to the parameter-controlling inputs, the computing devices including at least a data processor, a memory coupled to the processor, and a data display device coupled to the processor; one or more load interface modules each including a data processor for controlling the respective interface module and for monitoring data link signals, each of the load interface modules supporting at least one device-control data link network; a control-resources data link network connecting the control devices, the computing devices, and the load interface modules; and at least one device-control data link network having a common path for connecting the load interface module to a plurality of multiple-parameter lamp units having a plurality of adjustable parameters relating to beam characteristics and a driver for controlling a plurality of the parameters in response to the parameter-controlling inputs.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:-

1. A distributed control system for a lighting system, comprising:

A. one or more control devices for entering parameter-controlling inputs according to a specified format, said parameter-controlling inputs directing the operation of said lighting system, said control devices including a data processor coupled to said parameter-controlling inputs and a memory coupled to said processor;

B. one or more computing devices for storing, editing, and displaying data related to said parameter-controlling inputs, said computing devices comprising at least a data processor, a memory coupled to said processor, and a data display device coupled to said processor;

C. one or more load interface modules each including a data processor for controlling said respective interface module and for monitoring data link signals, each of said load interface modules supporting at least one device-control data link network;

D. a control-resources data link network connecting said control devices, said computing devices, and said load interface modules;

E. at least one said device-control data link network having a common path for connecting said load interface module to a plurality of multiple-parameter lamp units each having means for producing a light beam having a plurality of adjustable parameters relating to beam characteristics and drive means for controlling a plurality of said parameters in response to said parameter-controlling inputs.

2. A method for operating a distributed control lighting system equipped with an intelligent lighting assistant, said lighting system comprising an input device, a reasoning engine, a data repository, a load interface module, a multiple parameter lamp unit and a network, the method comprising the steps of:

injecting an operator parameter command into the reasoning engine via the input device;

evaluating said operator command in the reasoning engine;

comparing said operator command to a three dimensional model resident in the data repository, the model comprising a representation of the system and a system operating environment;

calculating a system parameter adjustment based on said operator command and said three dimensional model;

composing a system command to achieve the parameter adjustment ordered by the operator command; and

transmitting said system command to the multiple parameter lamp via the load interface module and the network.

3. The method of claim 2, further comprising the step of:

displaying a representation of the three dimensional model as altered by the system parameter adjustment on a graphic display device.

4. The method of claim 2, further comprising the step of:

implementing the system command upon receipt of an additional operator command.

5. A method for programming operations of a distributed control lighting system equipped with an intelligent lighting assistant, said assistant comprising an operator command input device, a reasoning engine, a data repository, and a graphic display device, the method comprising the steps of:

injecting an operator command into the reasoning engine via the input device;

evaluating said operator command in the reasoning engine;

comparing said operator command to a three dimensional model resident in the data repository, the model comprising a representation of the system and a system operating environment;

calculating a system parameter adjustment based on said operator command and said three dimensional model;

composing a system command to achieve the parameter adjustment ordered by the operator command; and

displaying a representation of the three dimensional model as altered by the system parameter adjustment on the graphic display device.

6. In a distributed control lighting system connected by a network and comprising an operator command input device, a general purpose computer having a system data repository, a load interface module, and a multiple parameter lamp unit; an intelligent lighting assistant, said assistant comprising:

a reasoning engine interactively connected to said operator command input device and said system data repository, said reasoning engine configured to calculate system parameter adjustments and system commands responsive to said operator commands, and further connected to said interface module for transmitting said system commands via the network to the multiple parameter lamp unit;

said data repository maintaining a three dimensional model comprising a representation of the system and a system operating environment; and

a graphic display device, whereon said reasoning engine displays the results of implementing its calculations of system parameter adjustments and system commands responsive to said operator commands on said three dimensional model.

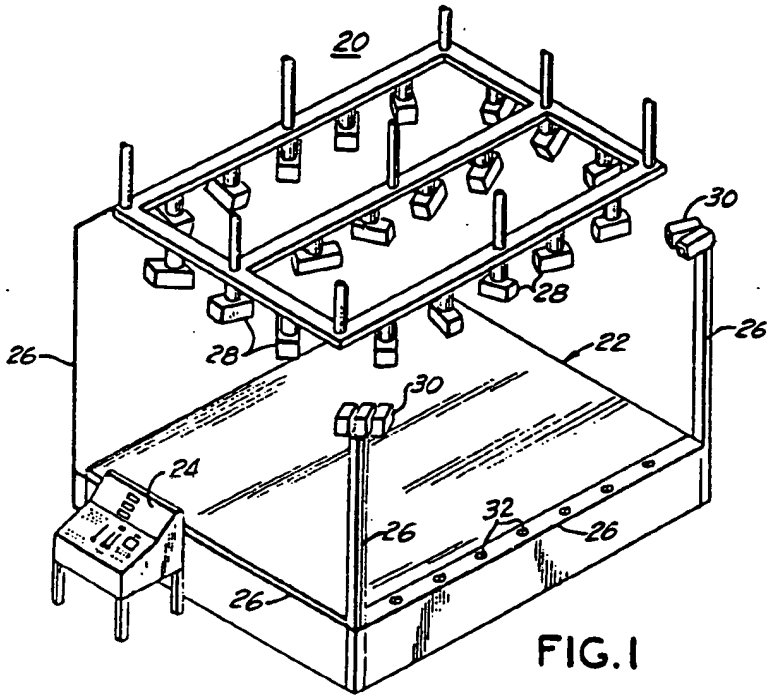

20
30
28
26
22
24
32

FIG.1

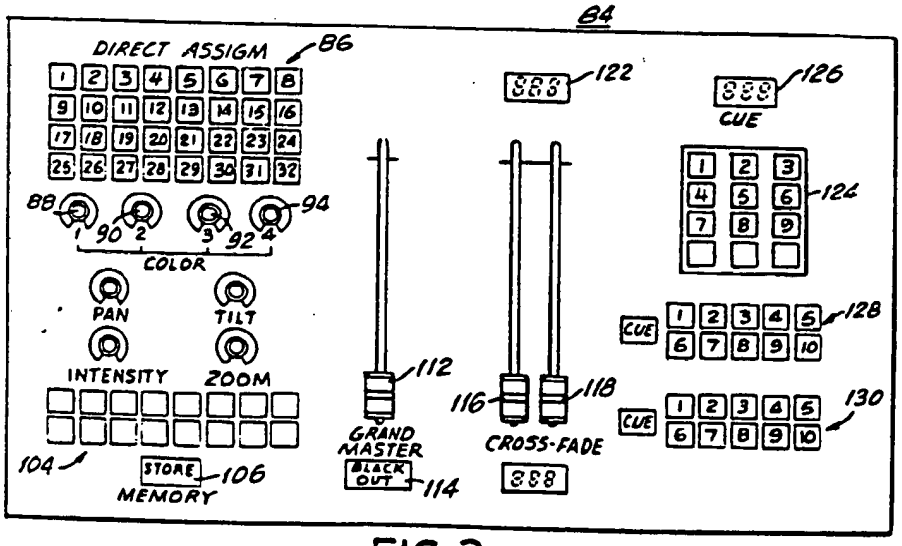

84
DIRECT ASSIGM
86
1 2 3 4 5 6 7 8
9 10 11 12 13 14 15 16
17 18 19 20 21 22 23 24
25 26 27 28 29 30 31 32
88
90
92
94
COLOR
PAN
TILT
INTENSITY
ZOOM
104
STORE
MEMORY
106
GRAND MASTER
112
BLACK OUT
114
122
116
118
CROSS-FADE
126
CUE
124
128
130

FIG.3

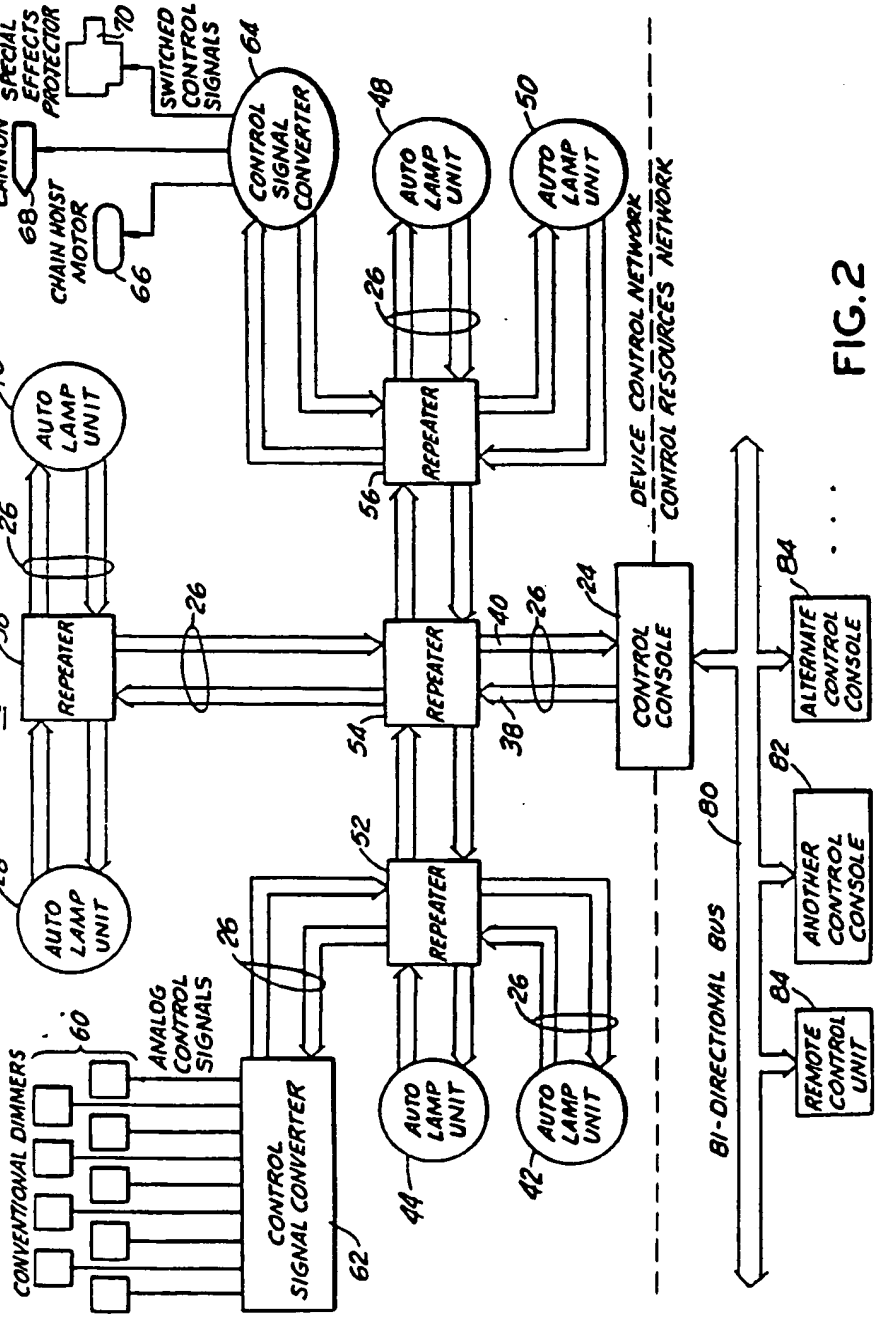

SPECIAL EFFECTS PROTECTOR
70
SWITCHED CONTROL SIGNALS
64
AIR CANNON
68
CHAIN HOIST MOTOR
66
CONTROL SIGNAL CONVERTER
AUTO LAMP UNIT
48
AUTO LAMP UNIT
50
26
REPEATER
56
DEVICE CONTROL NETWORK
CONTROL RESOURCES NETWORK
AUTO LAMP UNIT
46
26
58
REPEATER
26
20
40
26
24
CONTROL CONSOLE
84
ALTERNATE CONTROL CONSOLE
54
38
82
ANOTHER CONTROL CONSOLE
80
52
BI-DIRECTIONAL BUS
AUTO LAMP UNIT
28
REPEATER
26
84
REMOTE CONTROL UNIT
60
ANALOG CONTROL SIGNALS
CONVENTIONAL DIMMERS
CONTROL SIGNAL CONVERTER
62
AUTO LAMP UNIT
44
26
AUTO LAMP UNIT
42

FIG. 2

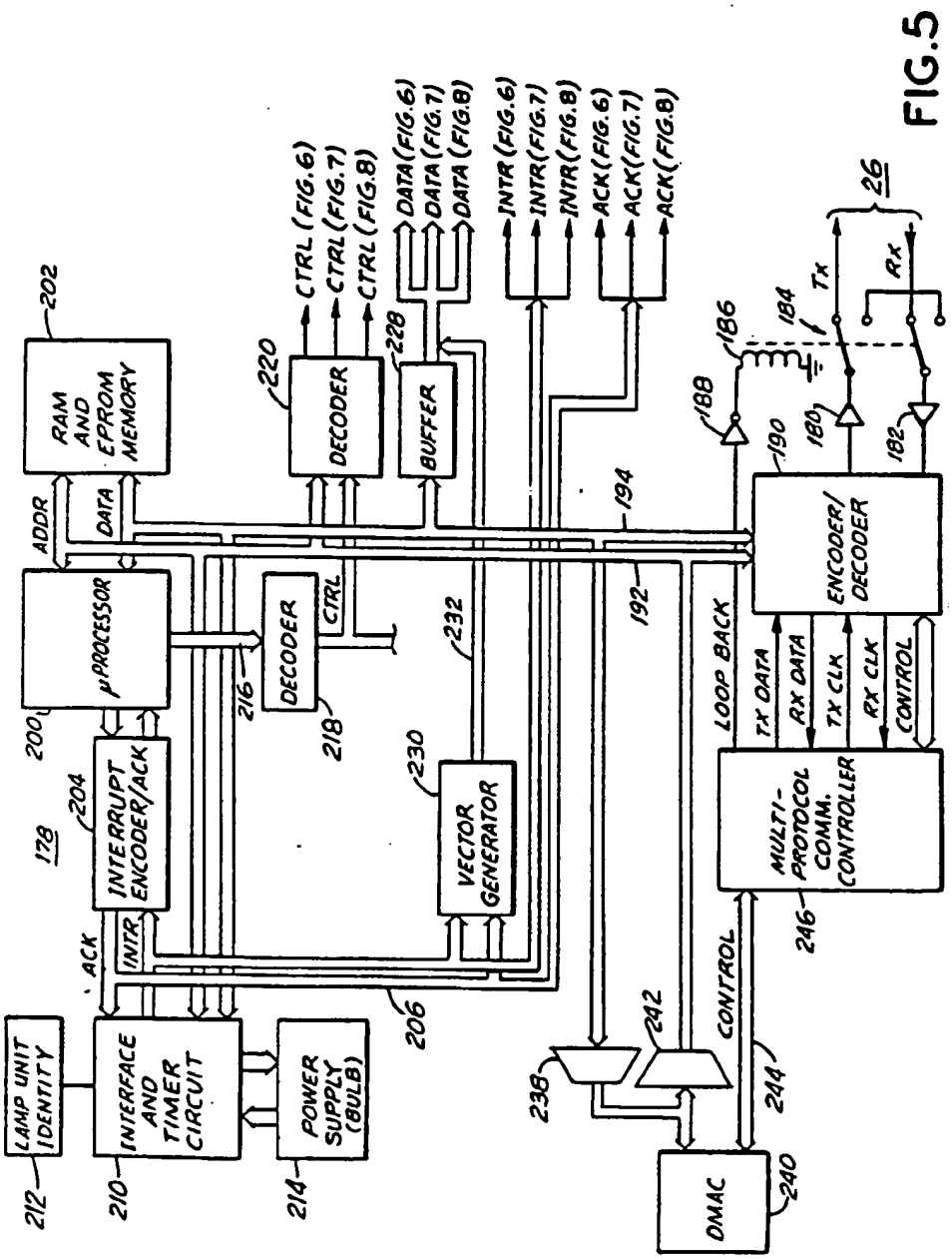

RAM AND EPROM MEMORY
202
ADDR
DATA
μPROCESSOR
200
INTERRUPT ENCODER/ACK
204
178
INTR
ACK
DECODER
216
CTRL
DECODER
220
BUFFER
228
CTRL (FIG.6)
CTRL (FIG.7)
CTRL (FIG.8)
DATA (FIG.6)
DATA (FIG.7)
DATA (FIG.8)
INTR (FIG.6)
INTR (FIG.7)
INTR (FIG.8)
ACK (FIG.6)
ACK (FIG.7)
ACK (FIG.8)
218
232
VECTOR GENERATOR
230
206
LAMP UNIT IDENTITY
212
INTERFACE AND TIMER CIRCUIT
210
POWER SUPPLY (BULB)
214
192
194
LOOP BACK
ENCODER/ DECODER
190
188
186
184
180
182
Tx
Rx
26
TX DATA
RX DATA
TX CLK
RX CLK
CONTROL
MULTI-PROTOCOL COMM. CONTROLLER
246
CONTROL
242
236
244
DMAC
240

FIG.5

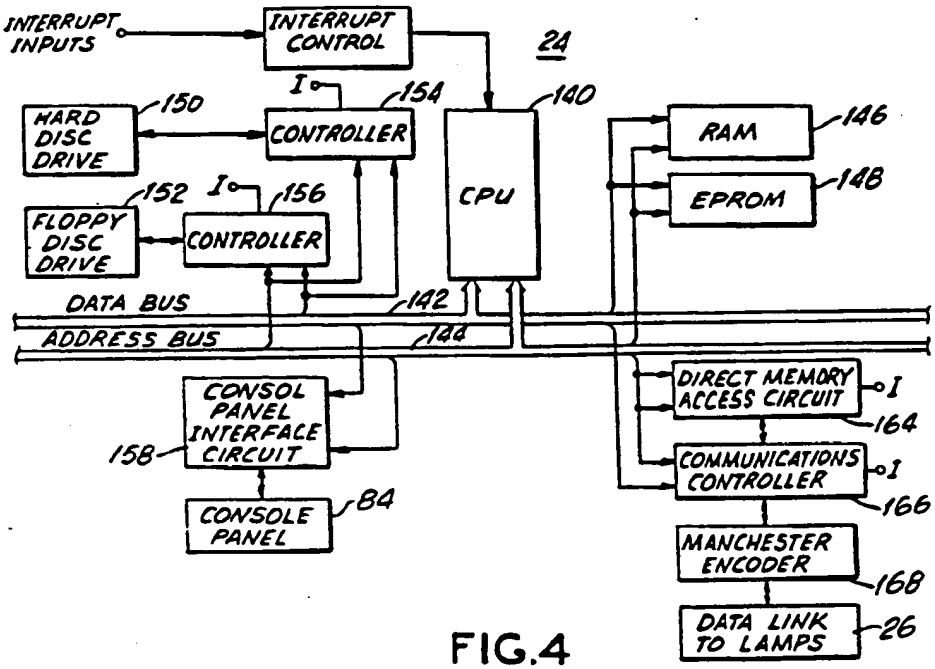


FIG.4

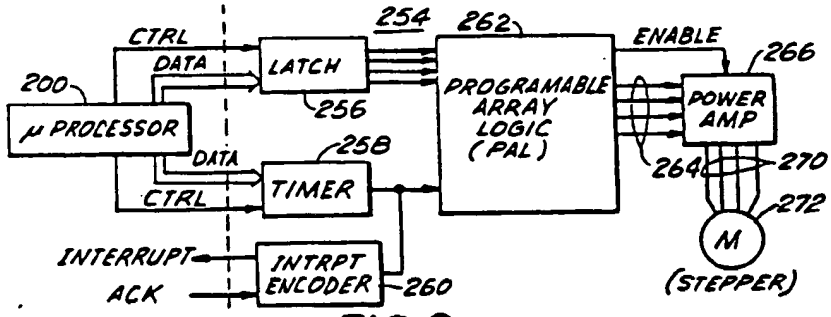


FIG.6

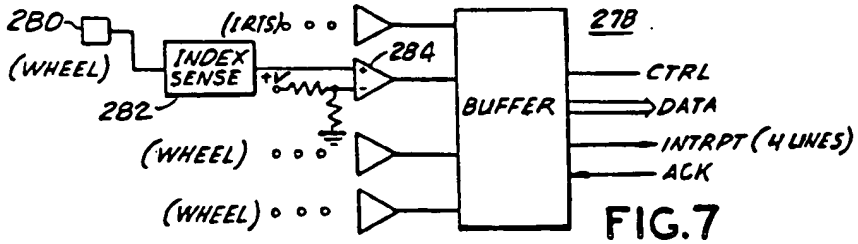


FIG.7

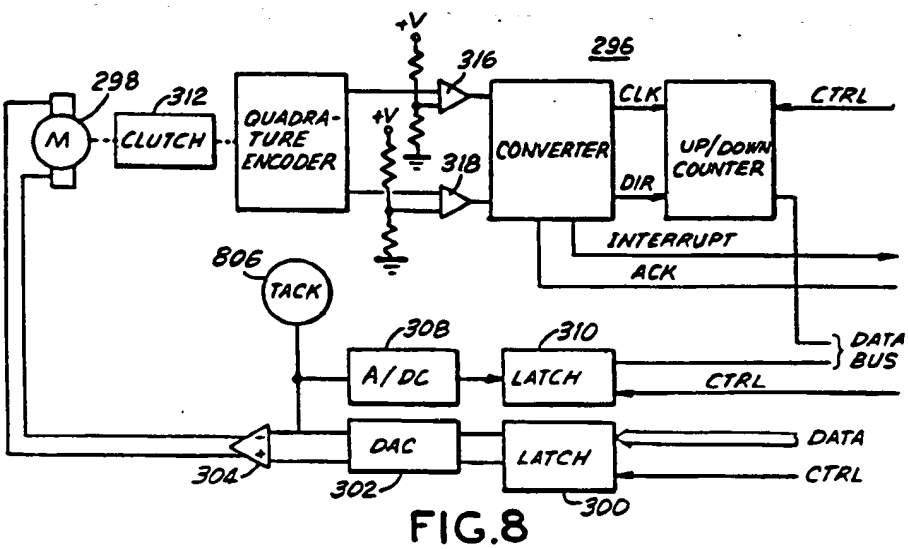

+V
316
296
298
312
QUADRA-TURE ENCODER
CLUTCH
M
+V
318
CONVERTER
CLK
DIR
UP/DOWN COUNTER
CTRL
INTERRUPT
ACK
806
TACK
308
310
A/DC
LATCH
DATA BUS
CTRL
DAC
LATCH
DATA
CTRL
304
302
300

FIG.8

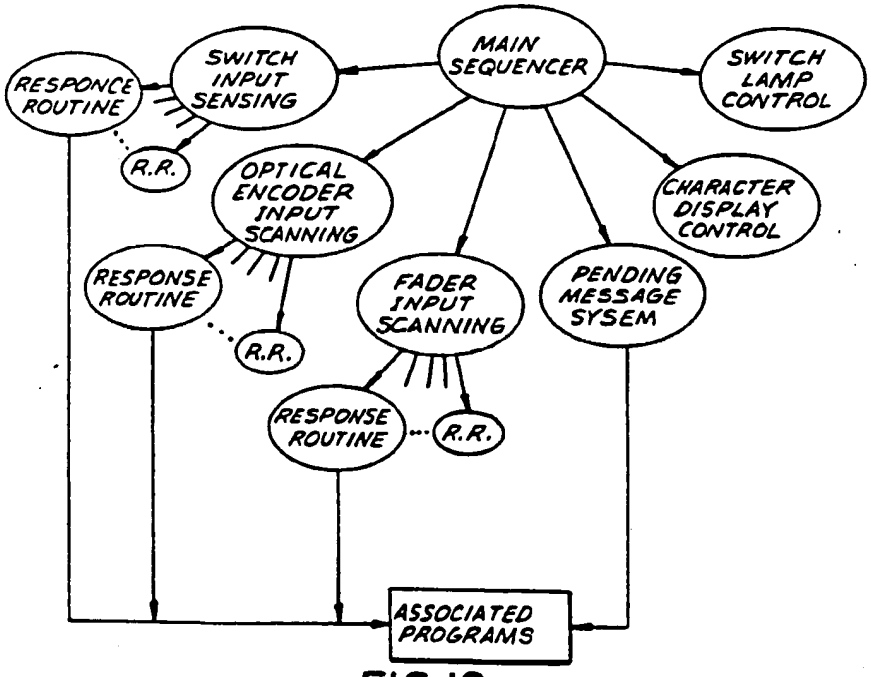

MAIN SEQUENCER
SWITCH INPUT SENSING
RESPONCE ROUTINE
R.R.
SWITCH LAMP CONTROL
OPTICAL ENCODER INPUT SCANNING
CHARACTER DISPLAY CONTROL
RESPONSE ROUTINE
R.R.
FADER INPUT SCANNING
PENDING MESSAGE SYSEM
RESPONSE ROUTINE
R.R.
ASSOCIATED PROGRAMS

FIG.10

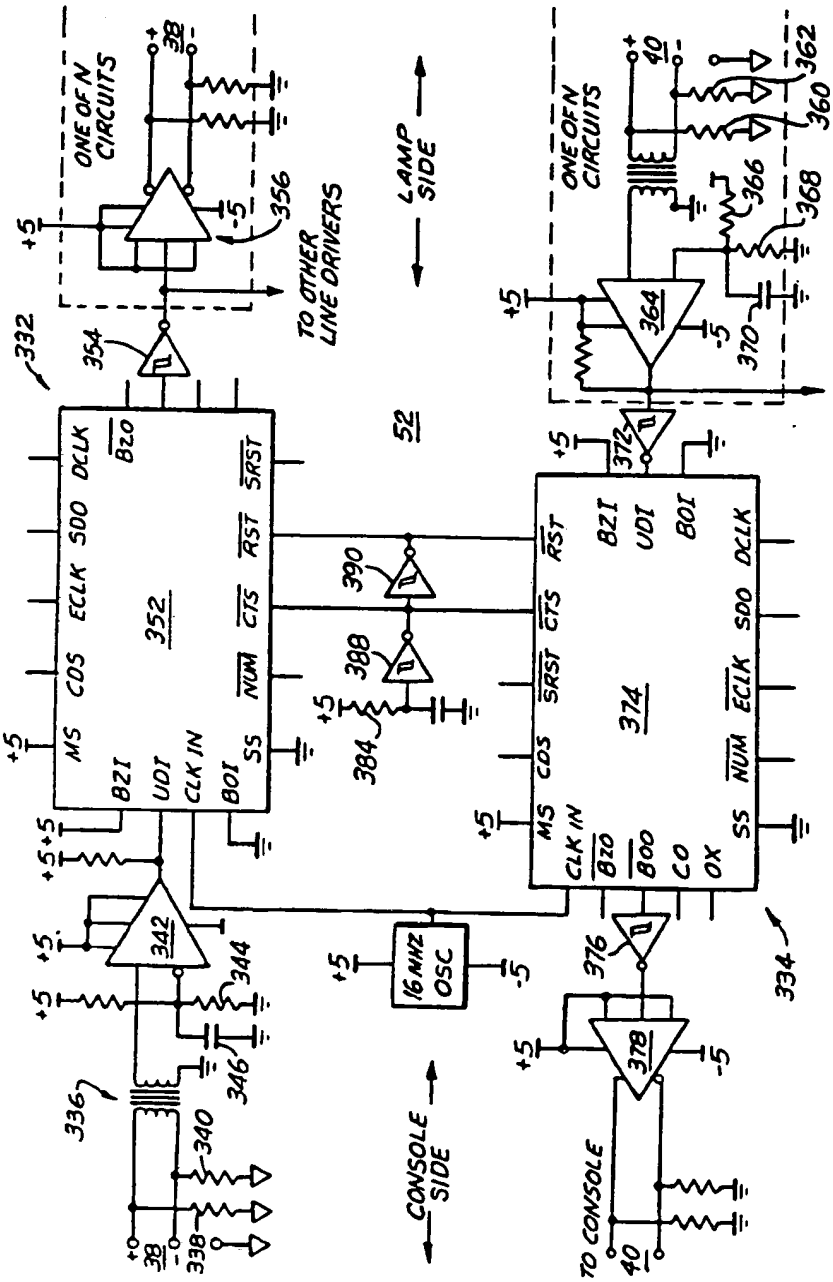

ONE OF N CIRCUITS
TO OTHER LINE DRIVERS
LAMP SIDE
CONSOLE SIDE
TO CONSOLE
16 MHZ OSC
352
374
332
334
336
342
344
346
340
338
354
356
358
360
362
364
366
368
370
372
376
378
380
382
384
386
388
390
52
MS
COS
ECLK
SDO
DCLK
BZO
BZI
UDI
CLK IN
BOI
SS
RST
SRST
CTS
NUM
BOO
CO
OX

FIG.9

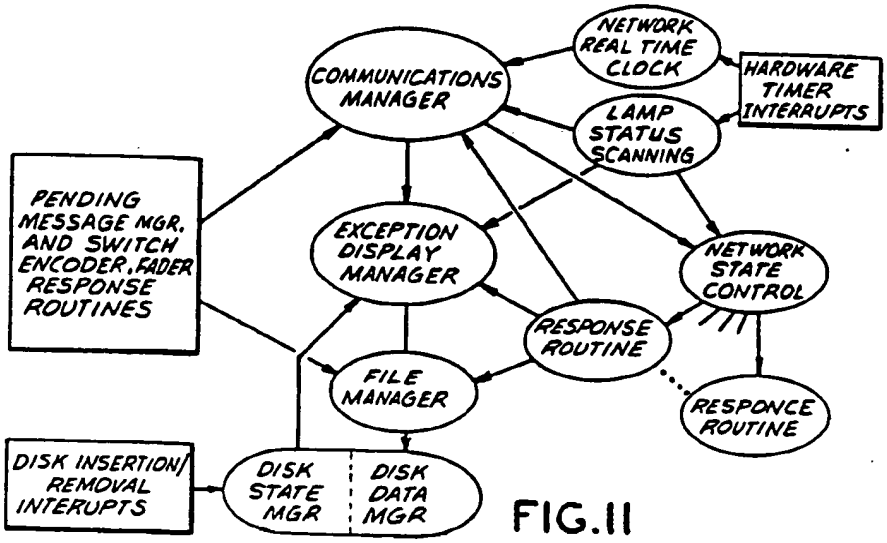

NETWORK REAL TIME CLOCK
HARDWARE TIMER INTERRUPTS
COMMUNICATIONS MANAGER
LAMP STATUS SCANNING
PENDING MESSAGE MGR. AND SWITCH ENCODER, FADER RESPONSE ROUTINES
EXCEPTION DISPLAY MANAGER
NETWORK STATE CONTROL
RESPONSE ROUTINE
FILE MANAGER
RESPONCE ROUTINE
DISK INSERTION/ REMOVAL INTERUPTS
DISK STATE MGR
DISK DATA MGR

FIG.11

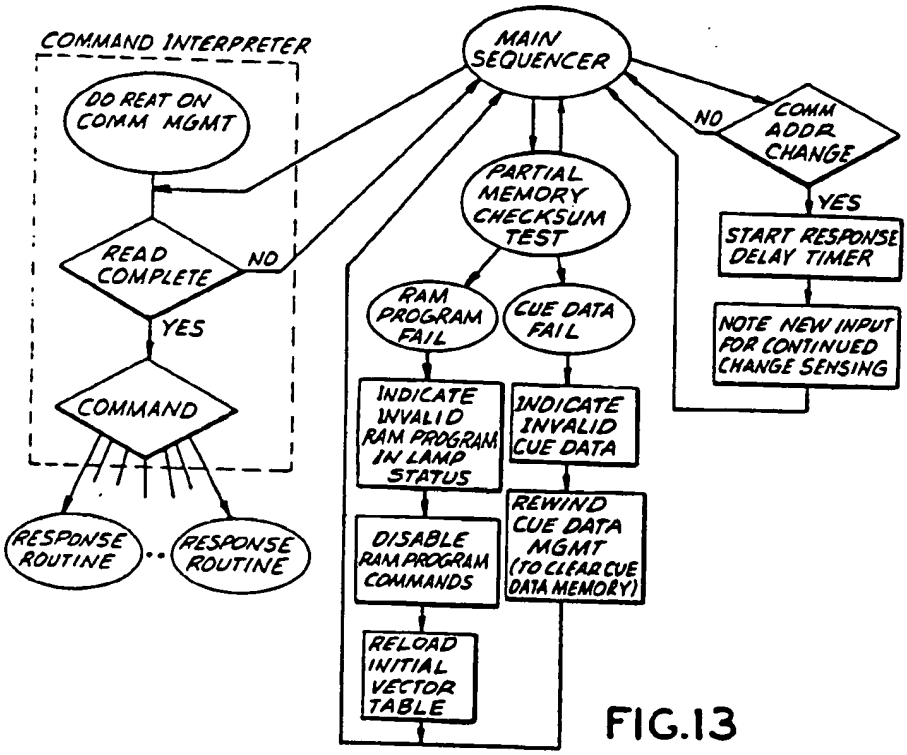

COMMAND INTERPRETER
MAIN SEQUENCER
DO REAT ON COMM MGMT
READ COMPLETE
NO
YES
COMMAND
RESPONSE ROUTINE
RESPONSE ROUTINE
PARTIAL MEMORY CHECKSUM TEST
RAM PROGRAM FAIL
CUE DATA FAIL
INDICATE INVALID RAM PROGRAM IN LAMP STATUS
INDICATE INVALID CUE DATA
DISABLE RAM PROGRAM COMMANDS
REWIND CUE DATA MGMT (TO CLEAR CUE DATA MEMORY)
RELOAD INITIAL VECTOR TABLE
NO
COMM ADDR. CHANGE
YES
START RESPONSE DELAY TIMER
NOTE NEW INPUT FOR CONTINUED CHANGE SENSING

FIG.13

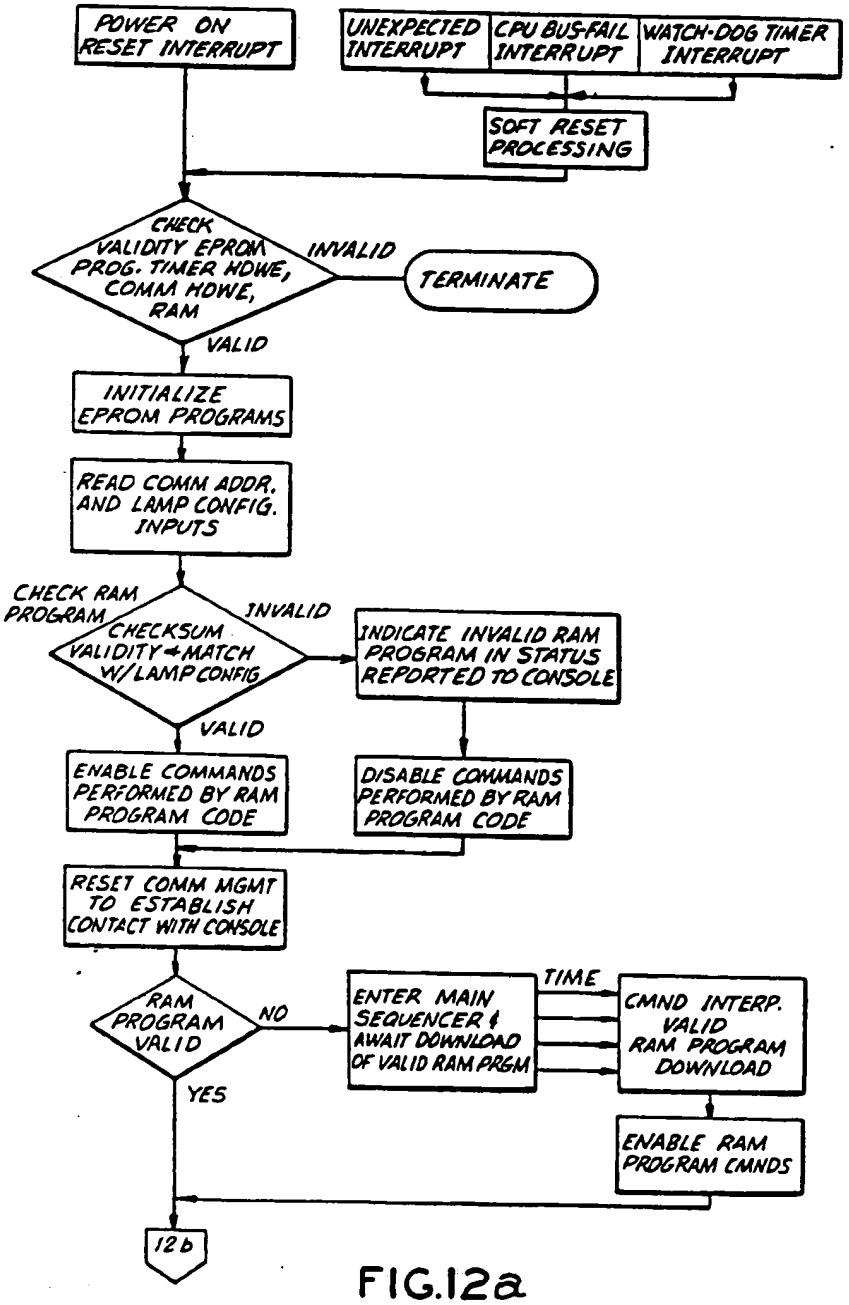

POWER ON RESET INTERRUPT
UNEXPECTED INTERRUPT
CPU BUS-FAIL INTERRUPT
WATCH-DOG TIMER INTERRUPT
SOFT RESET PROCESSING
CHECK VALIDITY EPROM PROG. TIMER HDWE, COMM HDWE, RAM
INVALID
TERMINATE
VALID
INITIALIZE EPROM PROGRAMS
READ COMM ADDR. AND LAMP CONFIG. INPUTS
CHECK RAM PROGRAM CHECKSUM VALIDITY & MATCH W/ LAMP CONFIG
INVALID
INDICATE INVALID RAM PROGRAM IN STATUS REPORTED TO CONSOLE
VALID
ENABLE COMMANDS PERFORMED BY RAM PROGRAM CODE
DISABLE COMMANDS PERFORMED BY RAM PROGRAM CODE
RESET COMM MGMT TO ESTABLISH CONTACT WITH CONSOLE
RAM PROGRAM VALID
NO
ENTER MAIN SEQUENCER & AWAIT DOWNLOAD OF VALID RAM PRGM
TIME
CMND INTERP. VALID RAM PROGRAM DOWNLOAD
ENABLE RAM PROGRAM CMNDS
YES
12b

FIG.12a

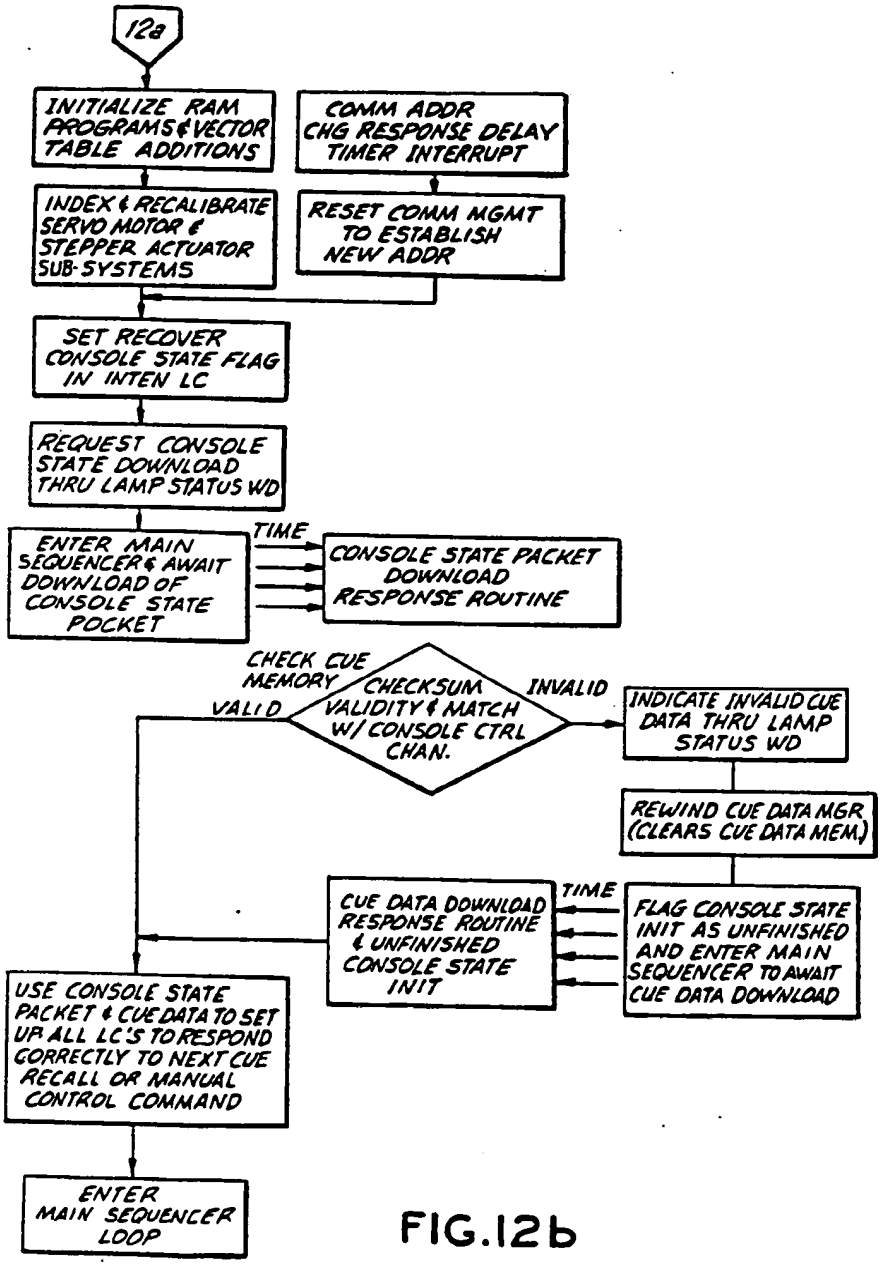

12a
INITIALIZE RAM PROGRAMS & VECTOR TABLE ADDITIONS
COMM ADDR CHG RESPONSE DELAY TIMER INTERRUPT
INDEX & RECALIBRATE SERVO MOTOR & STEPPER ACTUATOR SUB-SYSTEMS
RESET COMM MGMT TO ESTABLISH NEW ADDR
SET RECOVER CONSOLE STATE FLAG IN INTEN LC
REQUEST CONSOLE STATE DOWNLOAD THRU LAMP STATUS WD
ENTER MAIN SEQUENCER & AWAIT DOWNLOAD OF CONSOLE STATE POCKET
TIME
CONSOLE STATE PACKET DOWNLOAD RESPONSE ROUTINE
CHECK CUE MEMORY
CHECKSUM VALIDITY & MATCH W/ CONSOLE CTRL CHAN.
VALID
INVALID
INDICATE INVALID CUE DATA THRU LAMP STATUS WD
REWIND CUE DATA MGR (CLEARS CUE DATA MEM.)
TIME
CUE DATA DOWNLOAD RESPONSE ROUTINE & UNFINISHED CONSOLE STATE INIT
FLAG CONSOLE STATE INIT AS UNFINISHED AND ENTER MAIN SEQUENCER TO AWAIT CUE DATA DOWNLOAD
USE CONSOLE STATE PACKET & CUE DATA TO SET UP ALL LC'S TO RESPOND CORRECTLY TO NEXT CUE RECALL OR MANUAL CONTROL COMMAND
ENTER MAIN SEQUENCER LOOP

FIG.12b

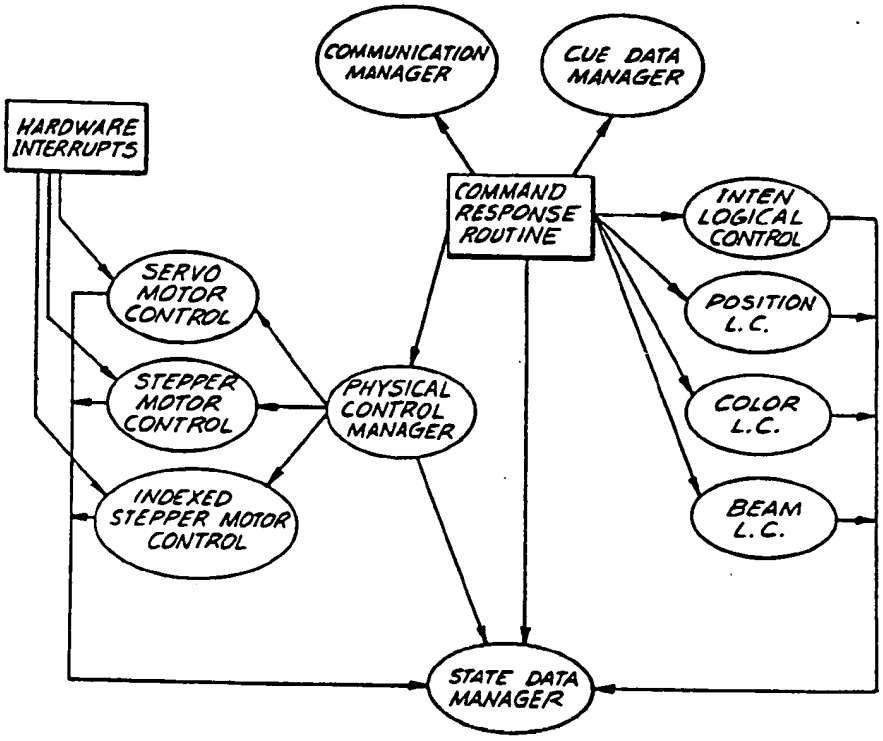

COMMUNICATION MANAGER
CUE DATA MANAGER
HARDWARE INTERRUPTS
COMMAND RESPONSE ROUTINE
INTEN LOGICAL CONTROL
SERVO MOTOR CONTROL
POSITION L.C.
STEPPER MOTOR CONTROL
PHYSICAL CONTROL MANAGER
COLOR L.C.
INDEXED STEPPER MOTOR CONTROL
BEAM L.C.
STATE DATA MANAGER

FIG. 14

1443-4190

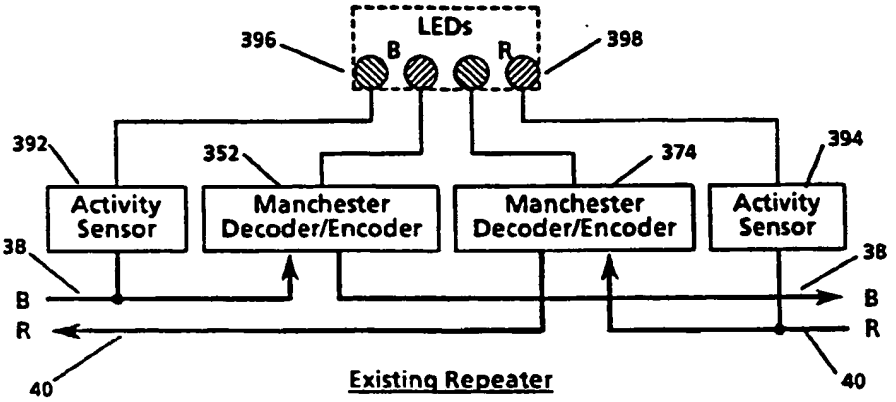


FIG. 15

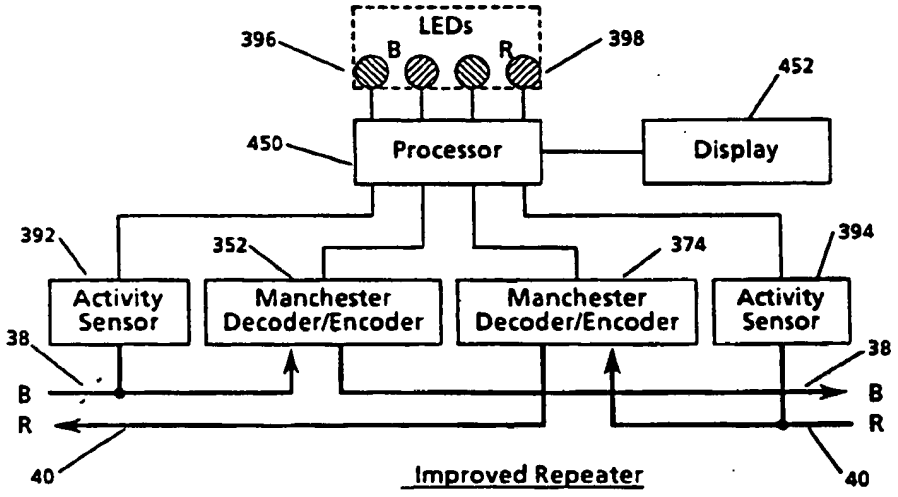


FIG. 20

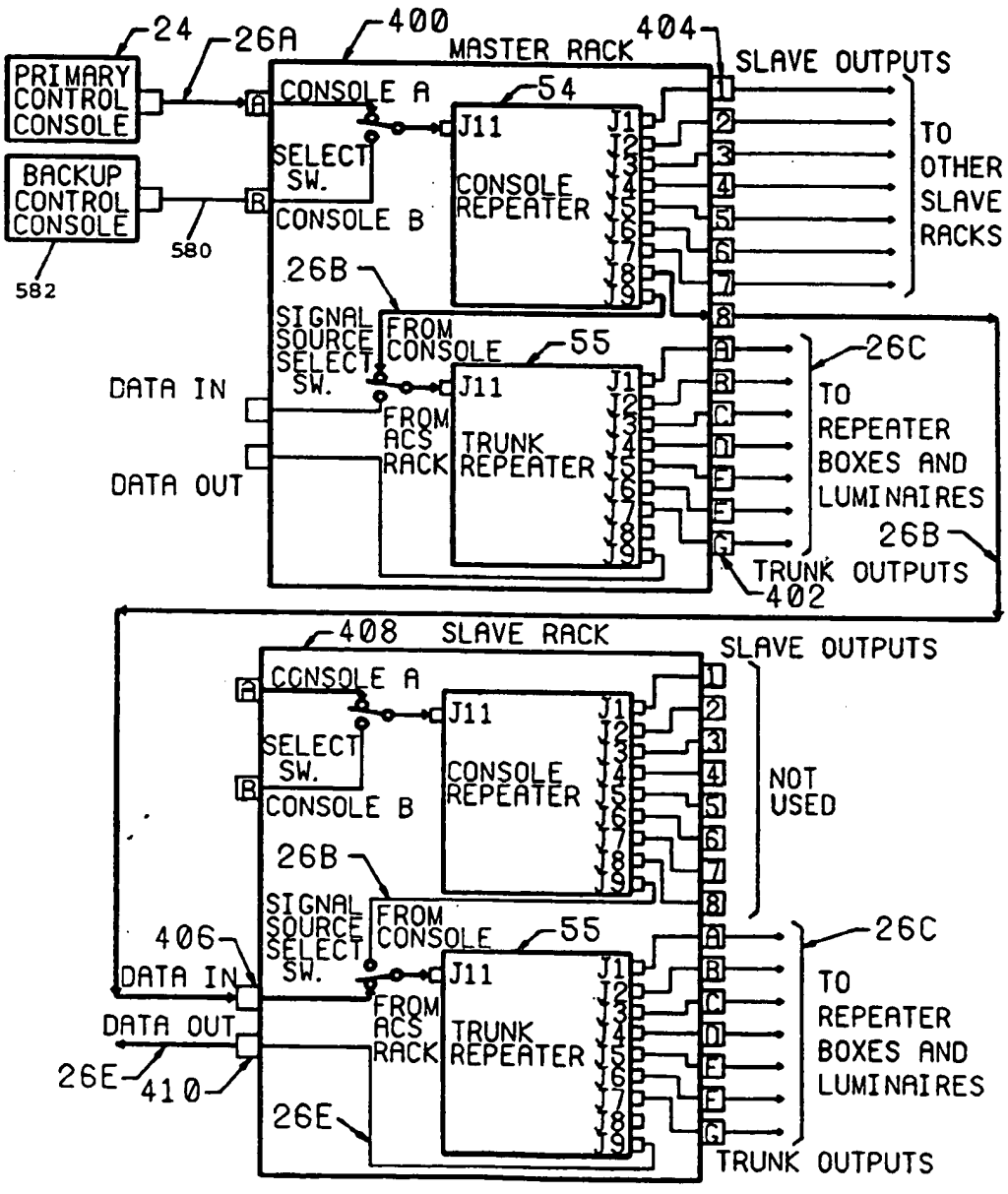

24
26A
400
MASTER RACK
404
SLAVE OUTPUTS
PRIMARY CONTROL CONSOLE
BACKUP CONTROL CONSOLE
582
580
CONSOLE A
SELECT SW.
CONSOLE B
54
J11
CONSOLE REPEATER
J1
J2
J3
J4
J5
J6
J7
J8
J9
TO OTHER SLAVE RACKS
26B
SIGNAL SOURCE SELECT SW.
FROM CONSOLE
55
DATA IN
DATA OUT
FROM ACS RACK
TRUNK REPEATER
26C
TO REPEATER BOXES AND LUMINAIRES
26B
TRUNK OUTPUTS
402
408
SLAVE RACK
SLAVE OUTPUTS
CONSOLE A
SELECT SW.
CONSOLE B
CONSOLE REPEATER
NOT USED
26B
406
SIGNAL SOURCE SELECT SW.
FROM CONSOLE
55
DATA IN
DATA OUT
26E
410
FROM ACS RACK
TRUNK REPEATER
26C
TO REPEATER BOXES AND LUMINAIRES
26E
TRUNK OUTPUTS

FIG.16

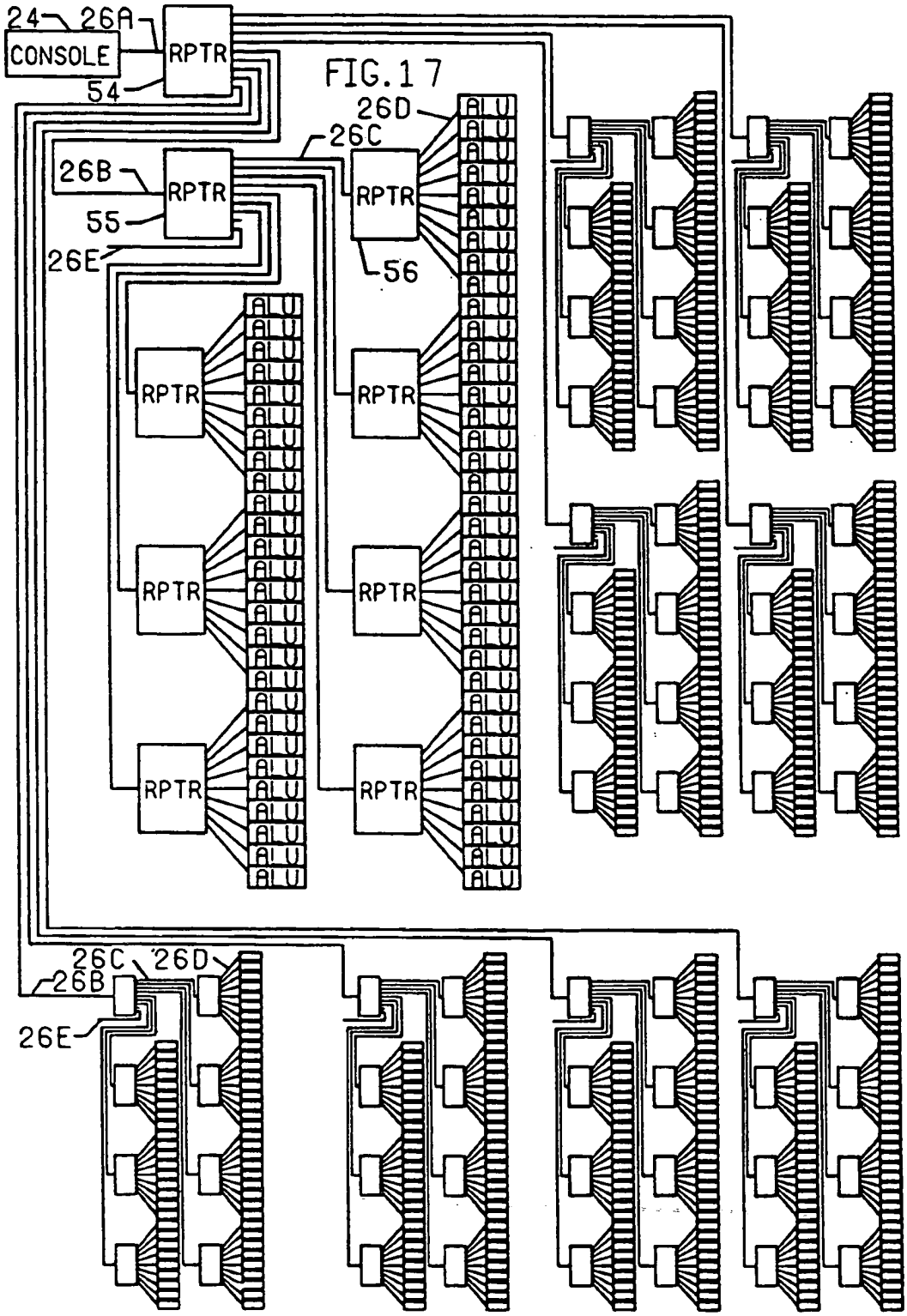


FIG. 17

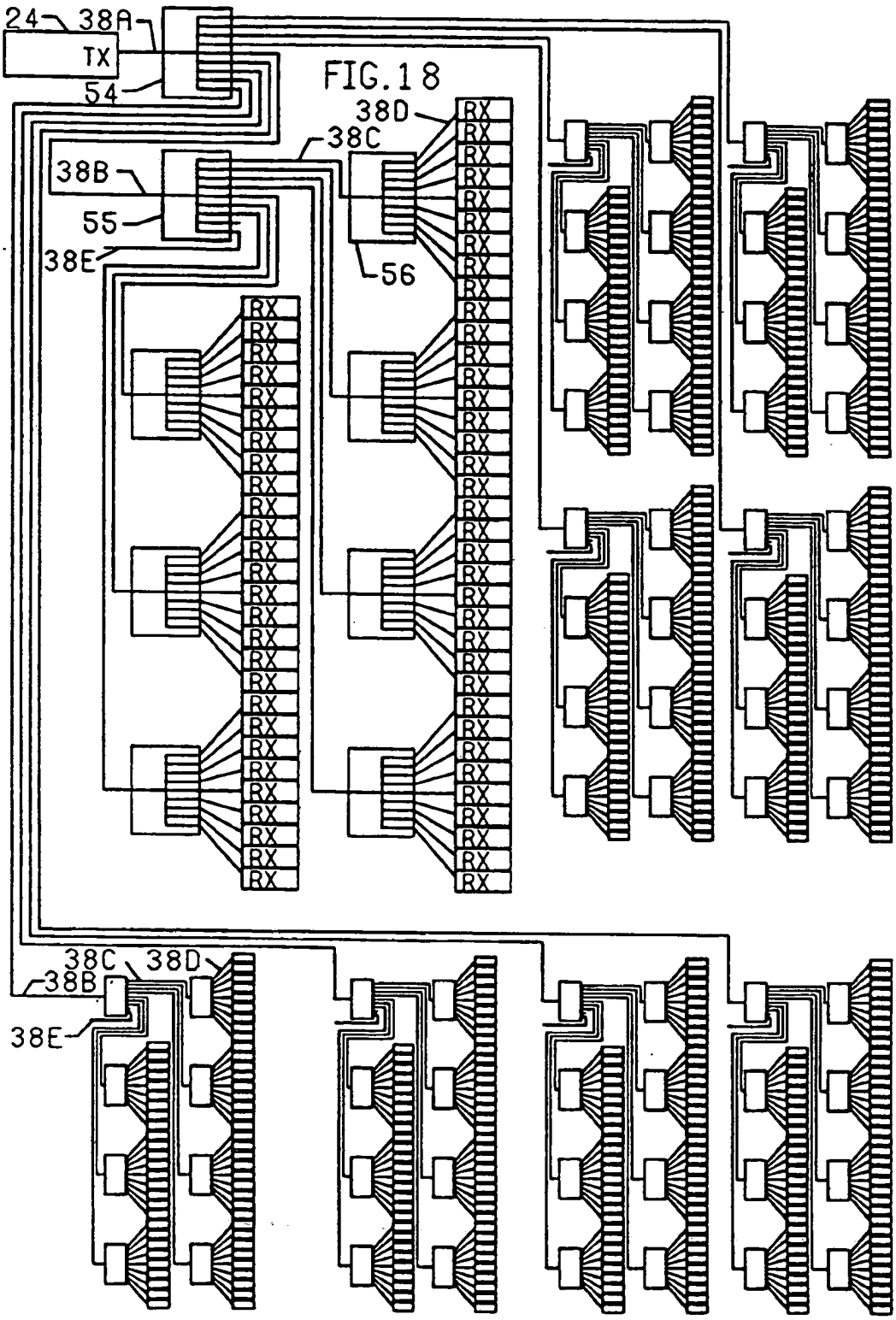


FIG.18

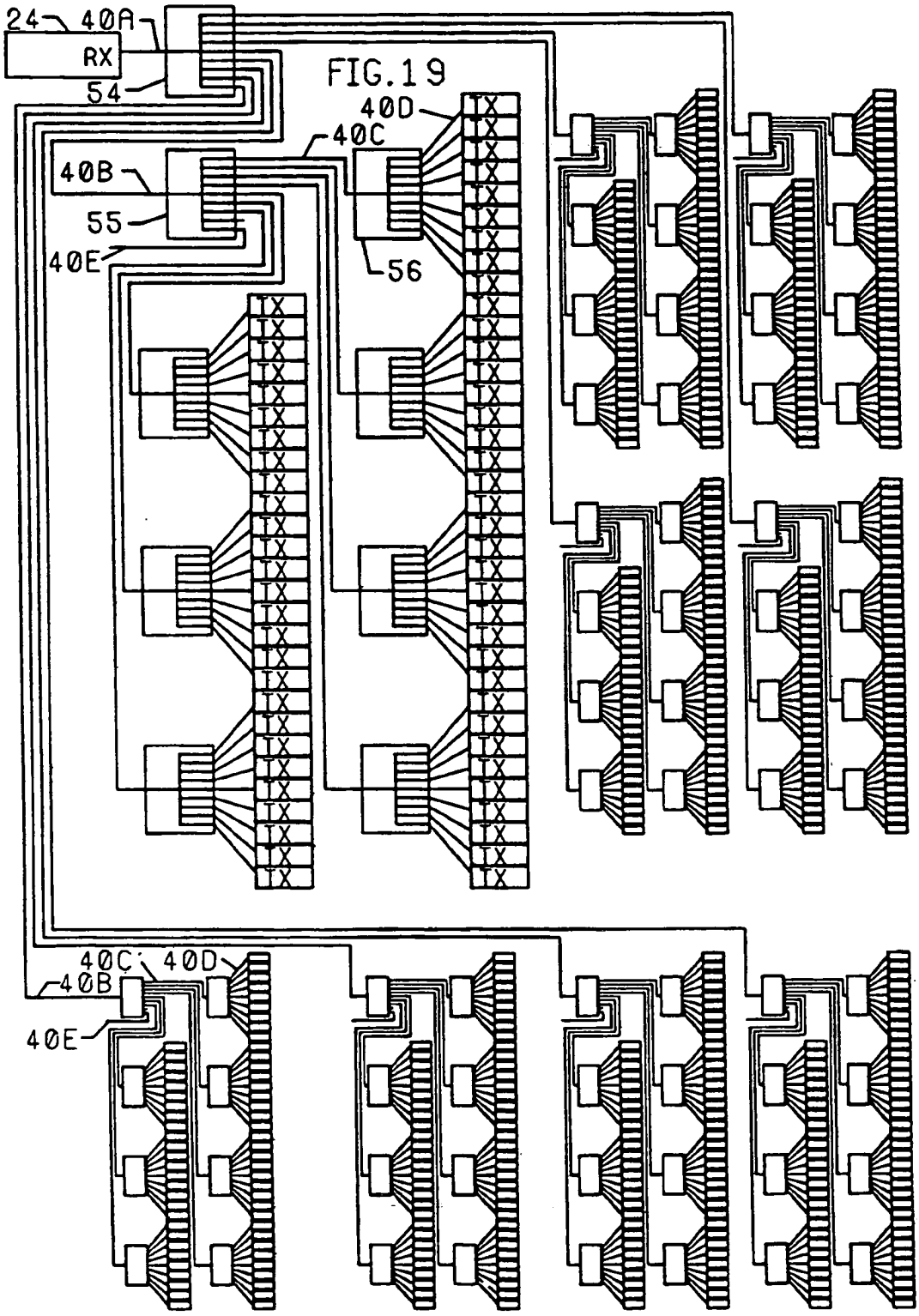
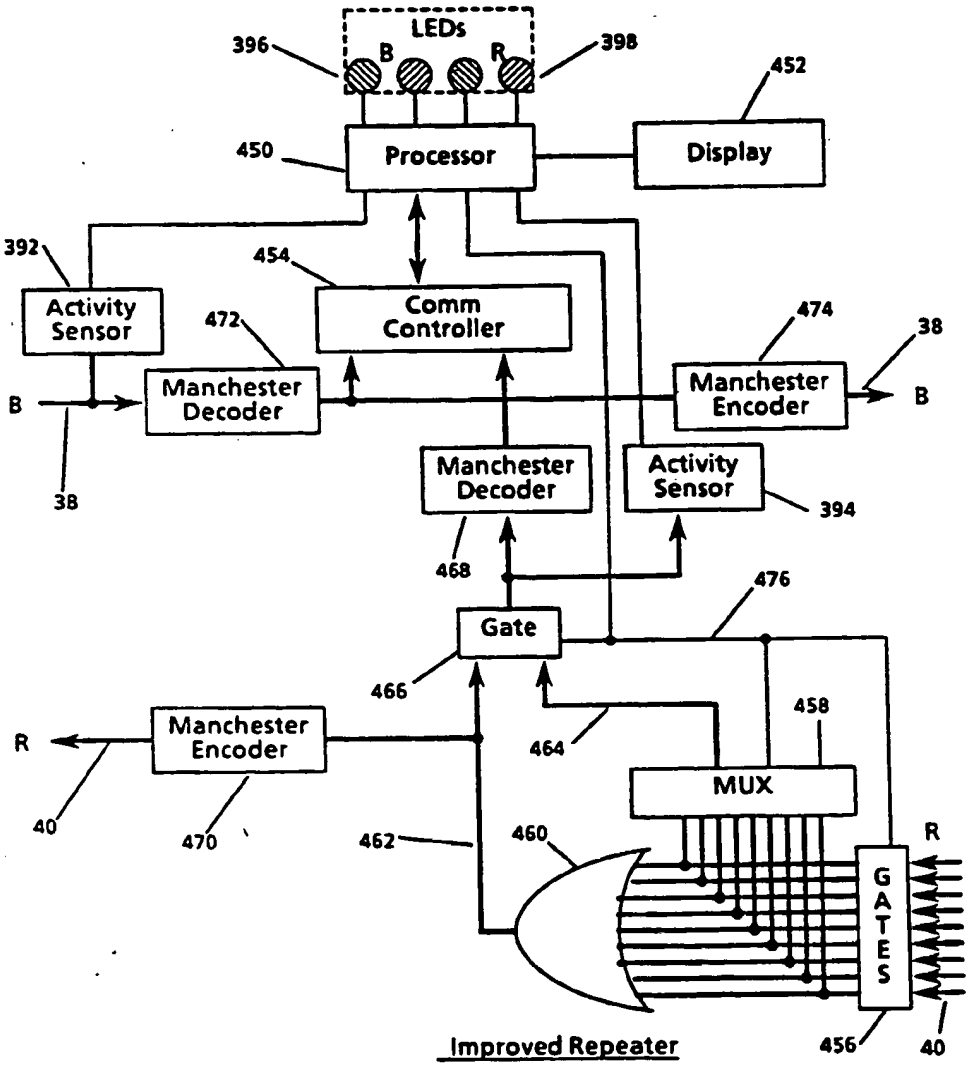


FIG.19

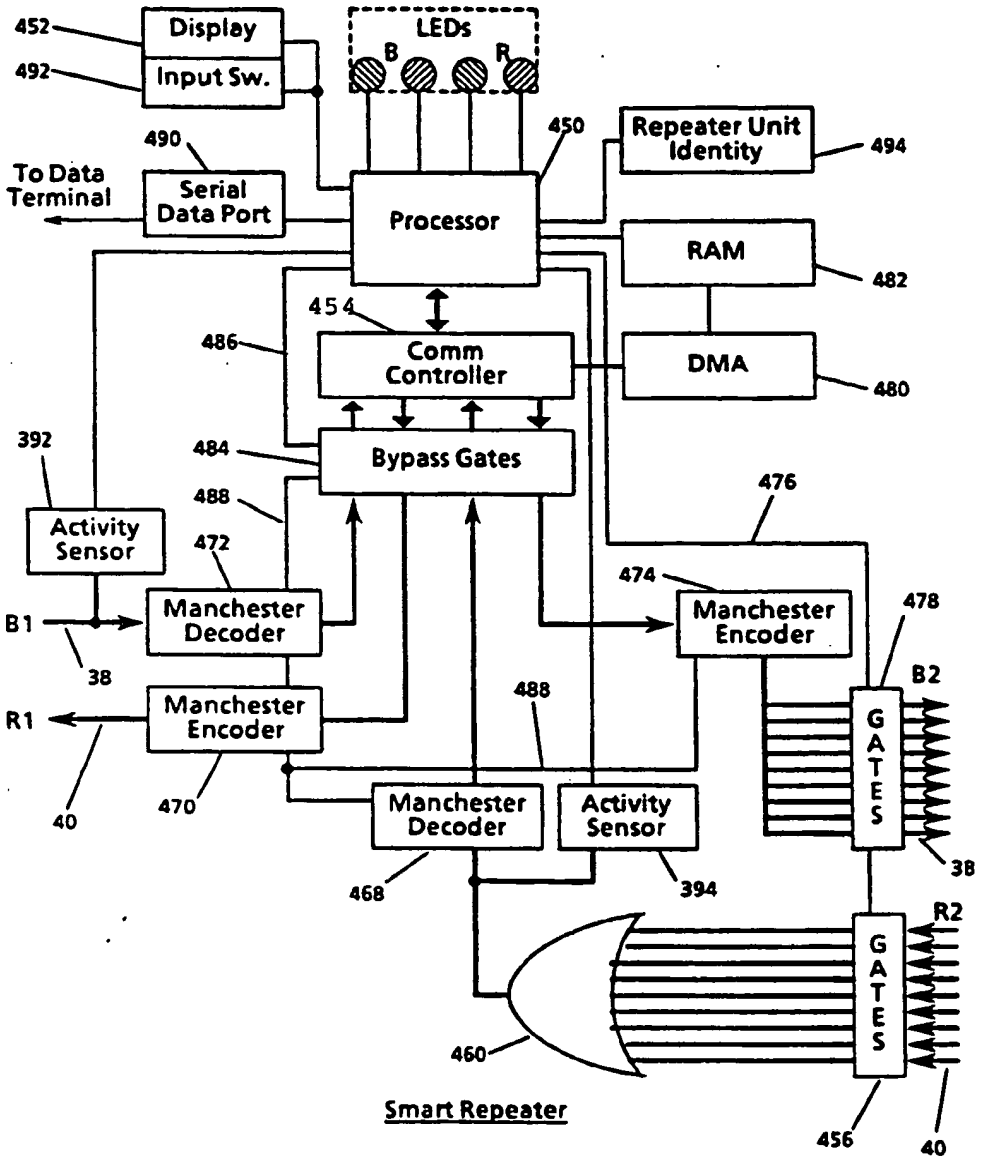
1443-4190



Improved Repeater

FIG. 21

1443-4190



Smart Repeater

FIG. 22

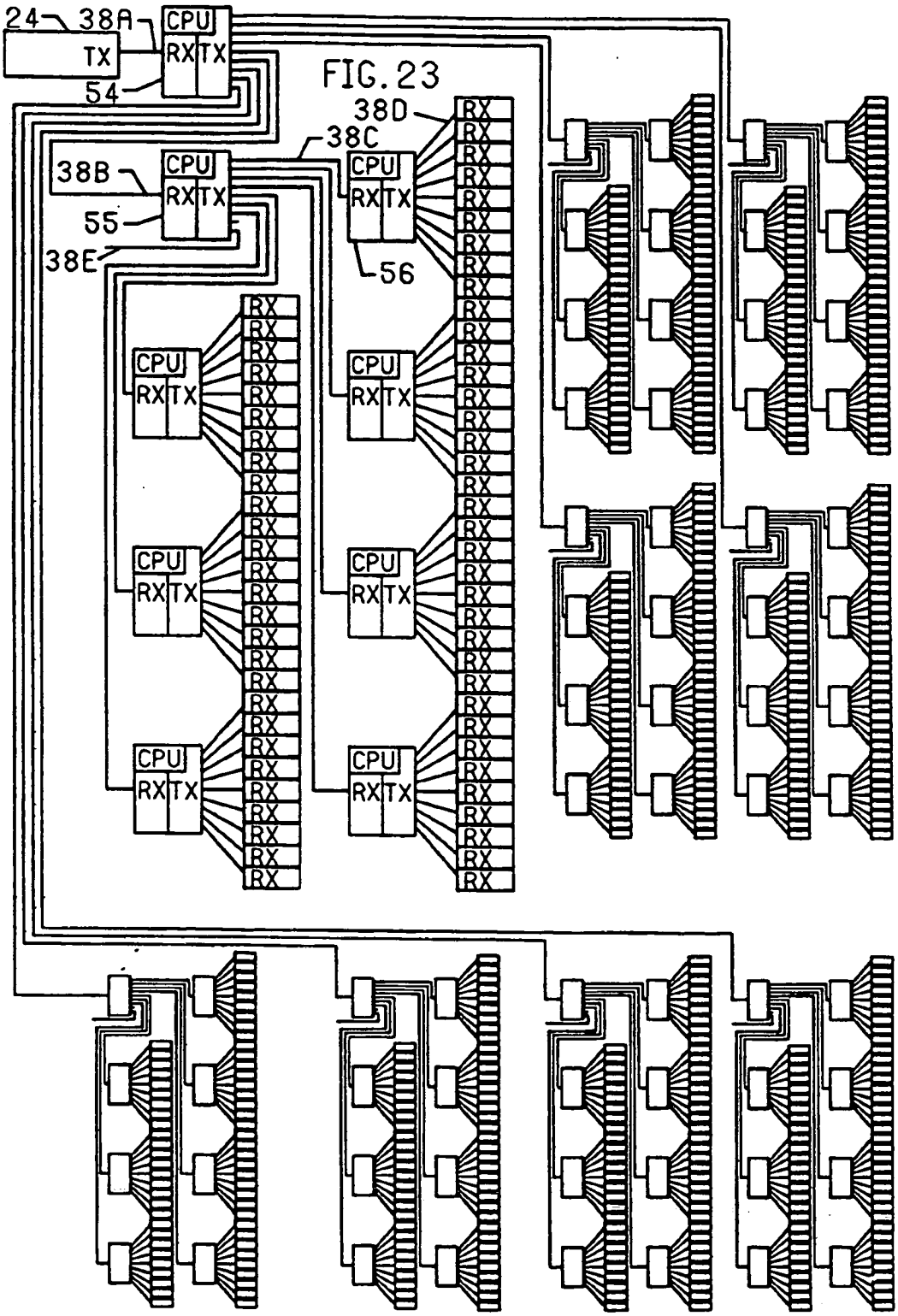


FIG. 23

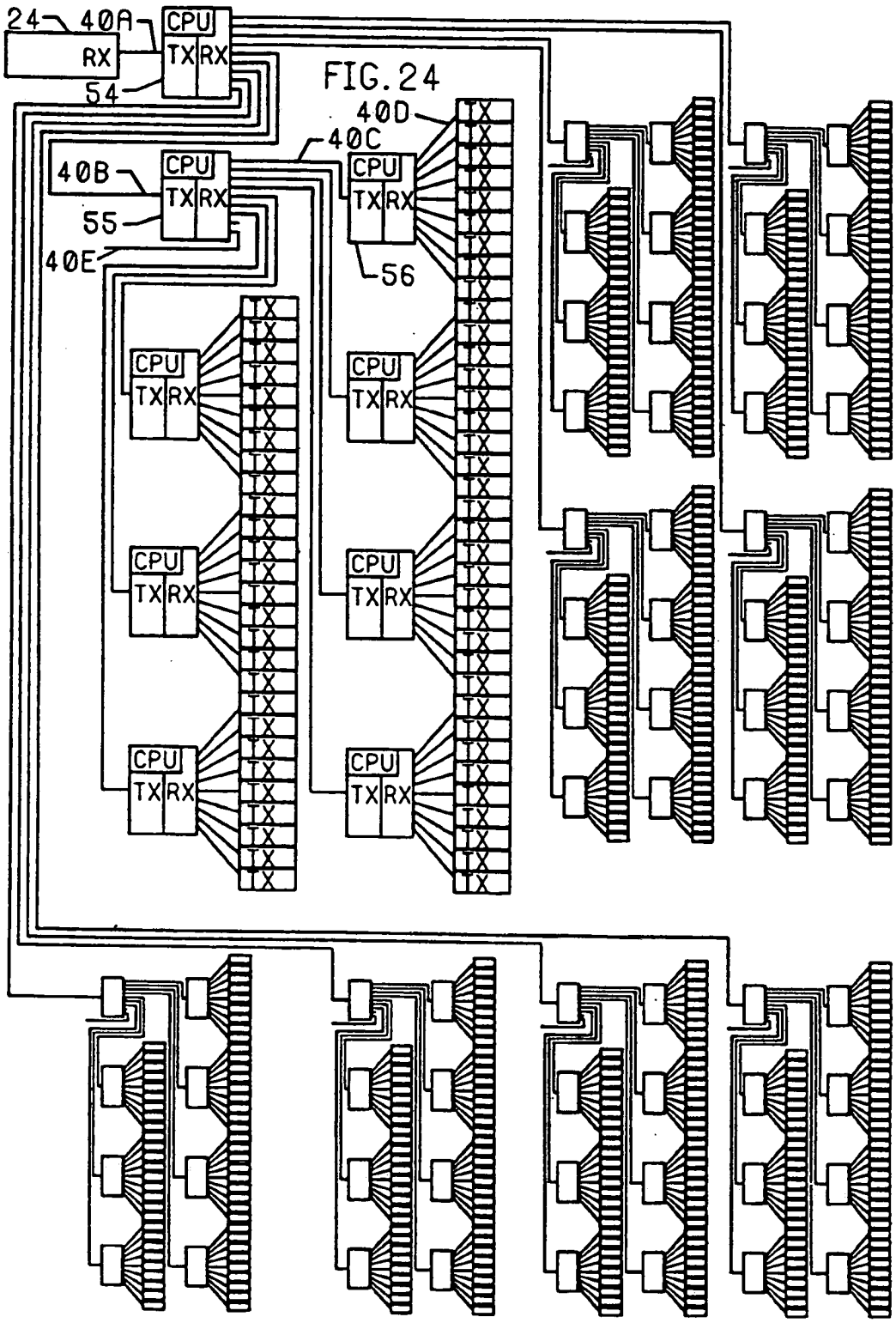


FIG. 24

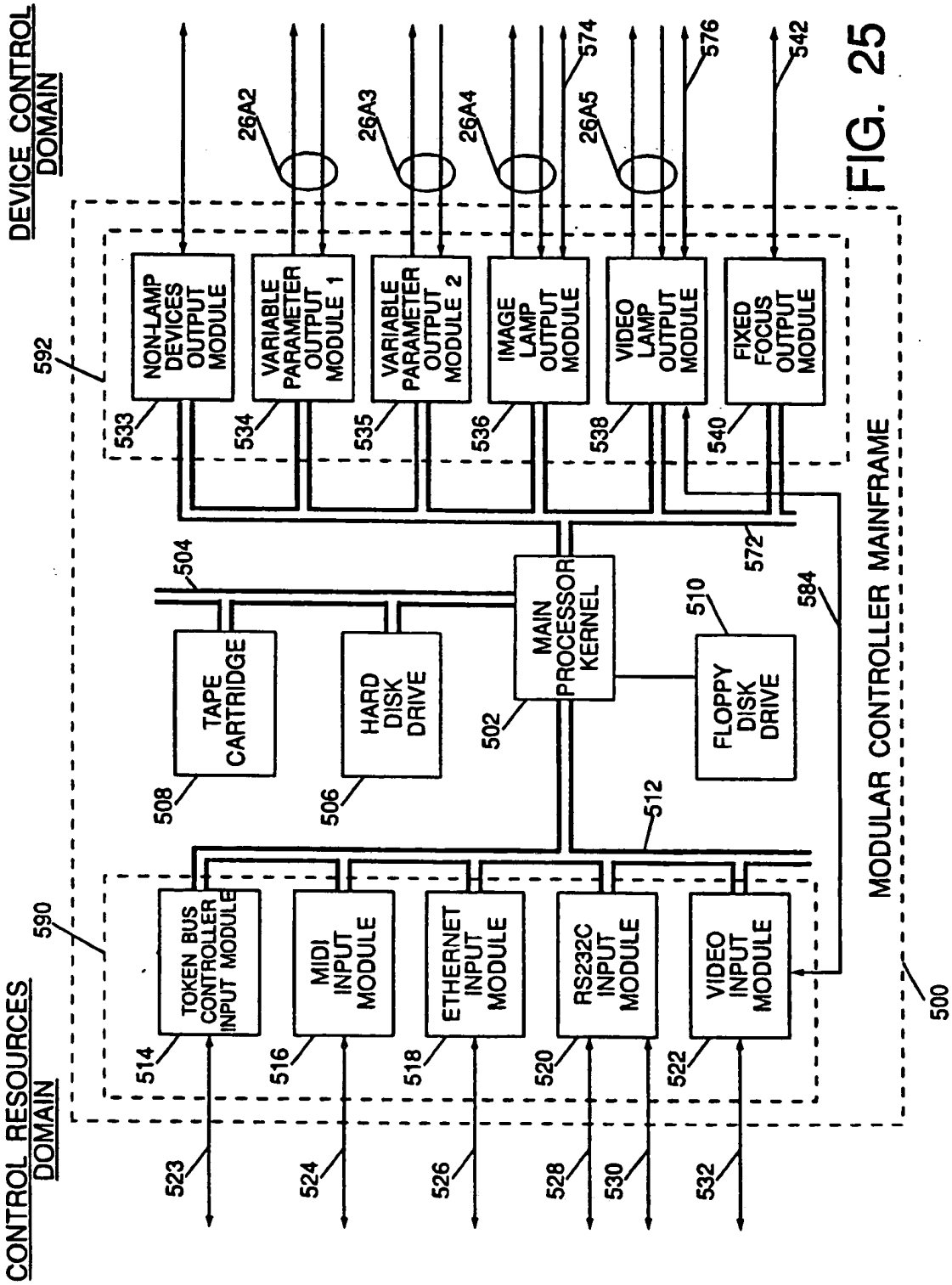

DEVICE CONTROL DOMAIN
CONTROL RESOURCES DOMAIN
MODULAR CONTROLLER MAINFRAME
NON-LAMP DEVICES OUTPUT MODULE
VARIABLE PARAMETER OUTPUT MODULE 1
VARIABLE PARAMETER OUTPUT MODULE 2
IMAGE LAMP OUTPUT MODULE
VIDEO LAMP OUTPUT MODULE
FIXED FOCUS OUTPUT MODULE
MAIN PROCESSOR KERNEL
TAPE CARTRIDGE
HARD DISK DRIVE
FLOPPY DISK DRIVE
TOKEN BUS CONTROLLER INPUT MODULE
MIDI INPUT MODULE
ETHERNET INPUT MODULE
RS232C INPUT MODULE
VIDEO INPUT MODULE
26A2
26A3
26A4
26A5
500
502
504
506
508
510
512
514
516
518
520
522
523
524
526
528
530
532
533
534
535
536
538
540
542
572
574
576
584
590
592

FIG. 25

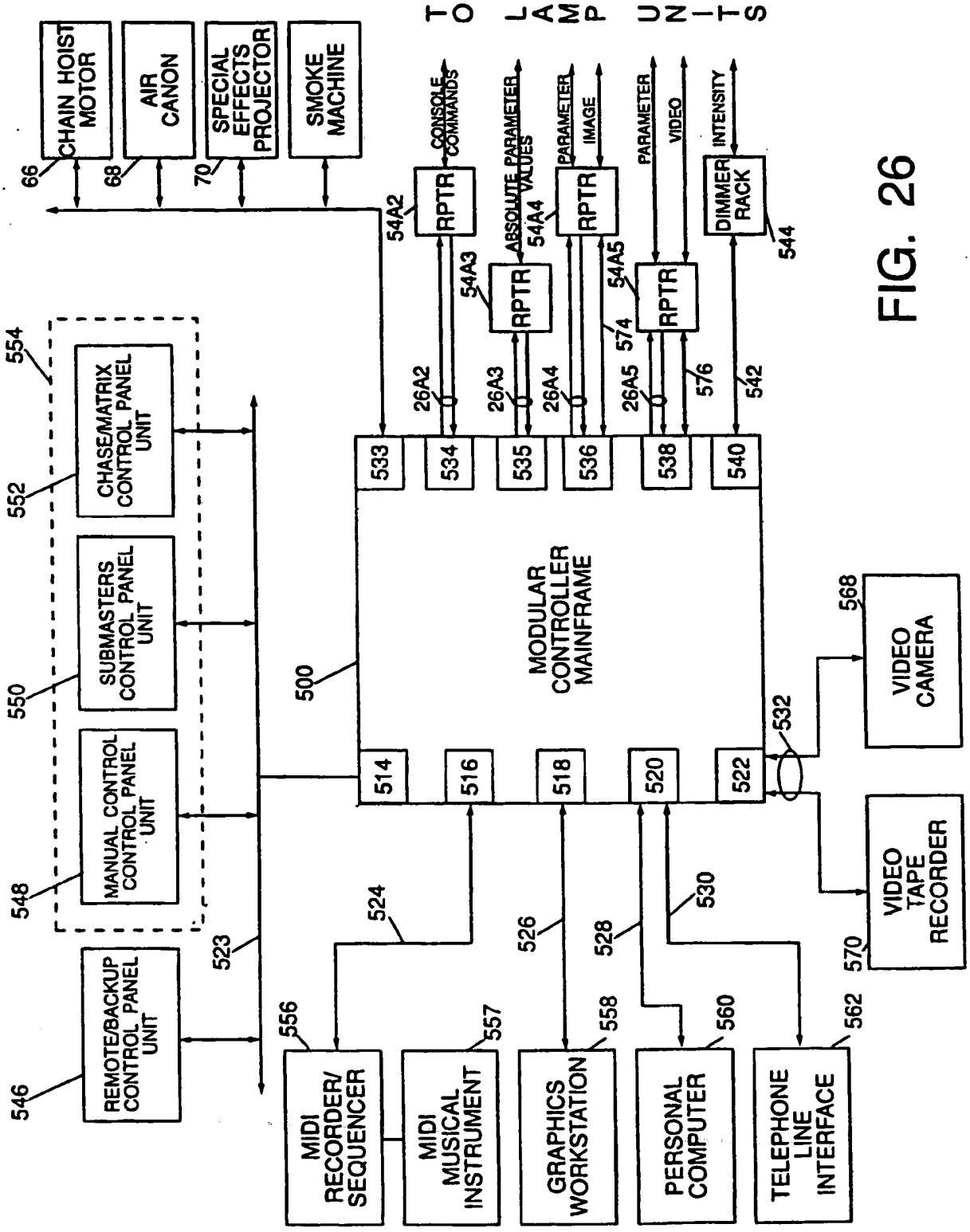

TO LAMP UNITS
CHAIN HOIST MOTOR
AIR CANON
SPECIAL EFFECTS PROJECTOR
SMOKE MACHINE
66
68
70
CONSOLE COMMANDS
ABSOLUTE PARAMETER VALUES
PARAMETER IMAGE
PARAMETER VIDEO
INTENSITY
RPTR
DIMMER RACK
544
54A2
54A3
54A4
54A5
574
576
542
26A2
26A3
26A4
26A5
533
534
535
536
538
540
MODULAR CONTROLLER MAINFRAME
500
514
516
518
520
522
532
554
552
550
548
CHASE/MATRIX CONTROL PANEL UNIT
SUBMASTERS CONTROL PANEL UNIT
MANUAL CONTROL CONTROL PANEL UNIT
REMOTE/BACKUP CONTROL PANEL UNIT
546
523
524
526
528
530
VIDEO CAMERA
568
VIDEO TAPE RECORDER
570
MIDI RECORDER/ SEQUENCER
556
MIDI MUSICAL INSTRUMENT
557
GRAPHICS WORKSTATION
558
PERSONAL COMPUTER
560
TELEPHONE LINE INTERFACE
562

FIG. 26

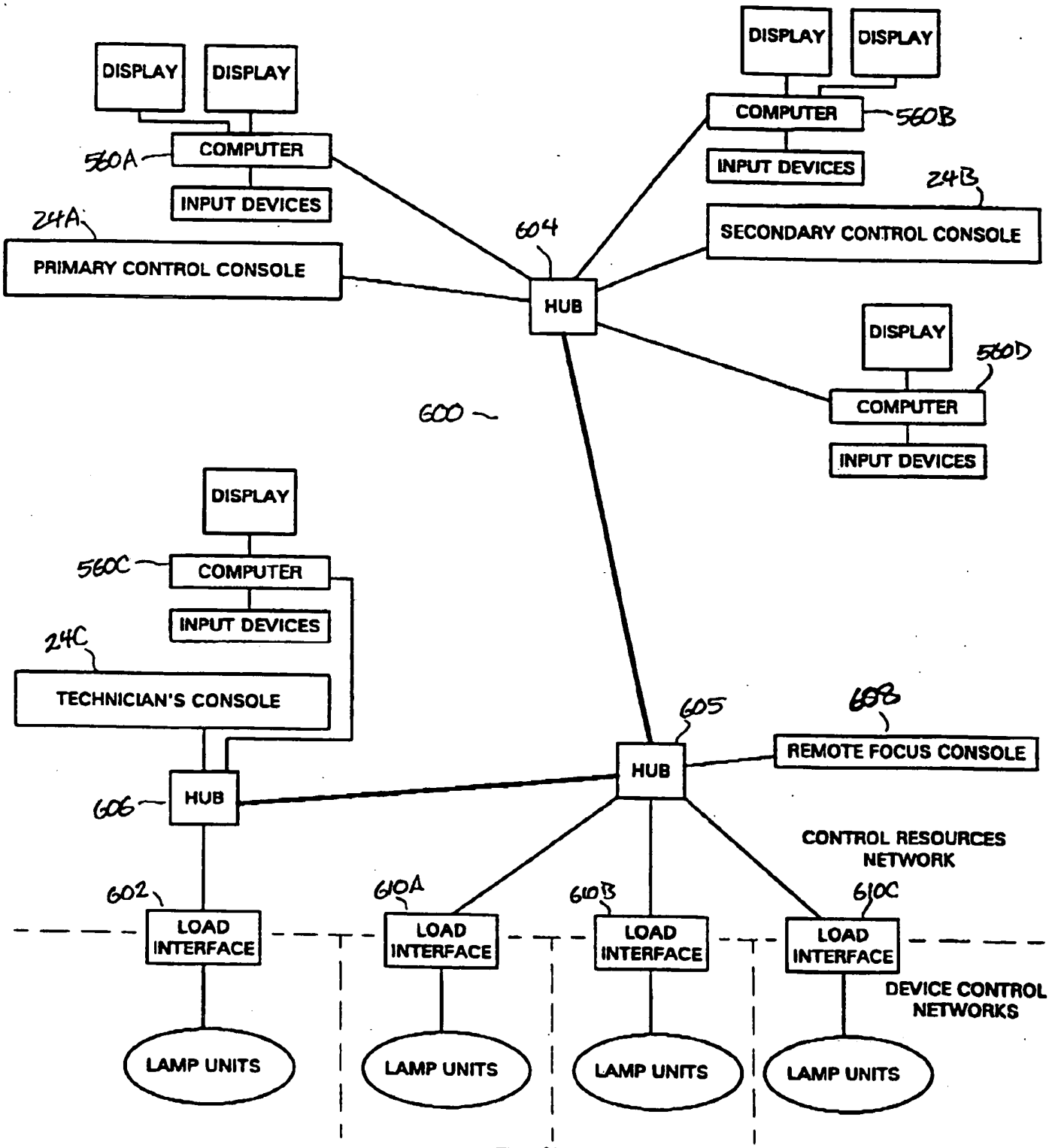

DISPLAY
DISPLAY
560A
COMPUTER
INPUT DEVICES
24A
PRIMARY CONTROL CONSOLE
DISPLAY
DISPLAY
COMPUTER
560B
INPUT DEVICES
24B
SECONDARY CONTROL CONSOLE
604
HUB
DISPLAY
560D
COMPUTER
INPUT DEVICES
600
DISPLAY
560C
COMPUTER
INPUT DEVICES
24C
TECHNICIAN'S CONSOLE
605
608
REMOTE FOCUS CONSOLE
HUB
606
HUB
CONTROL RESOURCES NETWORK
602
610A
610B
610C
LOAD INTERFACE
LOAD INTERFACE
LOAD INTERFACE
LOAD INTERFACE
DEVICE CONTROL NETWORKS
LAMP UNITS
LAMP UNITS
LAMP UNITS
LAMP UNITS

Fig. 27

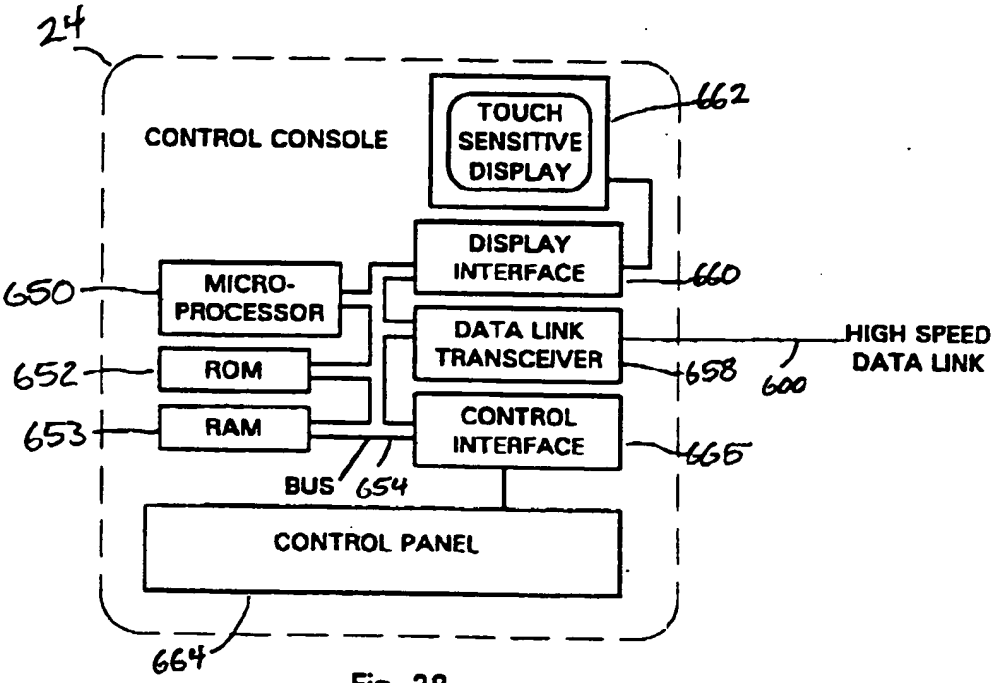

24
CONTROL CONSOLE
TOUCH SENSITIVE DISPLAY
662
DISPLAY INTERFACE
660
650
MICRO-PROCESSOR
DATA LINK TRANSCEIVER
HIGH SPEED DATA LINK
652
ROM
658
600
653
RAM
CONTROL INTERFACE
665
BUS
654
CONTROL PANEL
664

Fig. 28

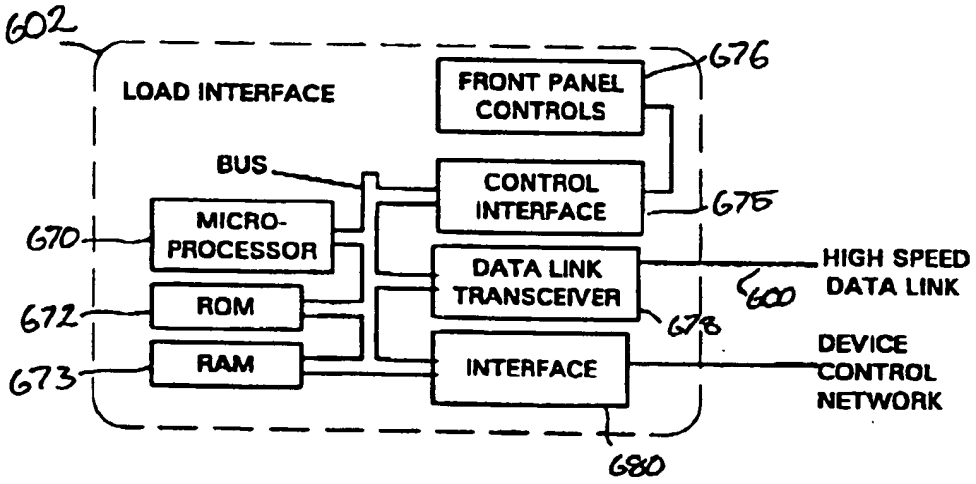

602
LOAD INTERFACE
FRONT PANEL CONTROLS
676
BUS
CONTROL INTERFACE
675
670
MICRO-PROCESSOR
DATA LINK TRANSCEIVER
HIGH SPEED DATA LINK
672
ROM
600
678
673
RAM
INTERFACE
DEVICE CONTROL NETWORK
680

Fig. 30

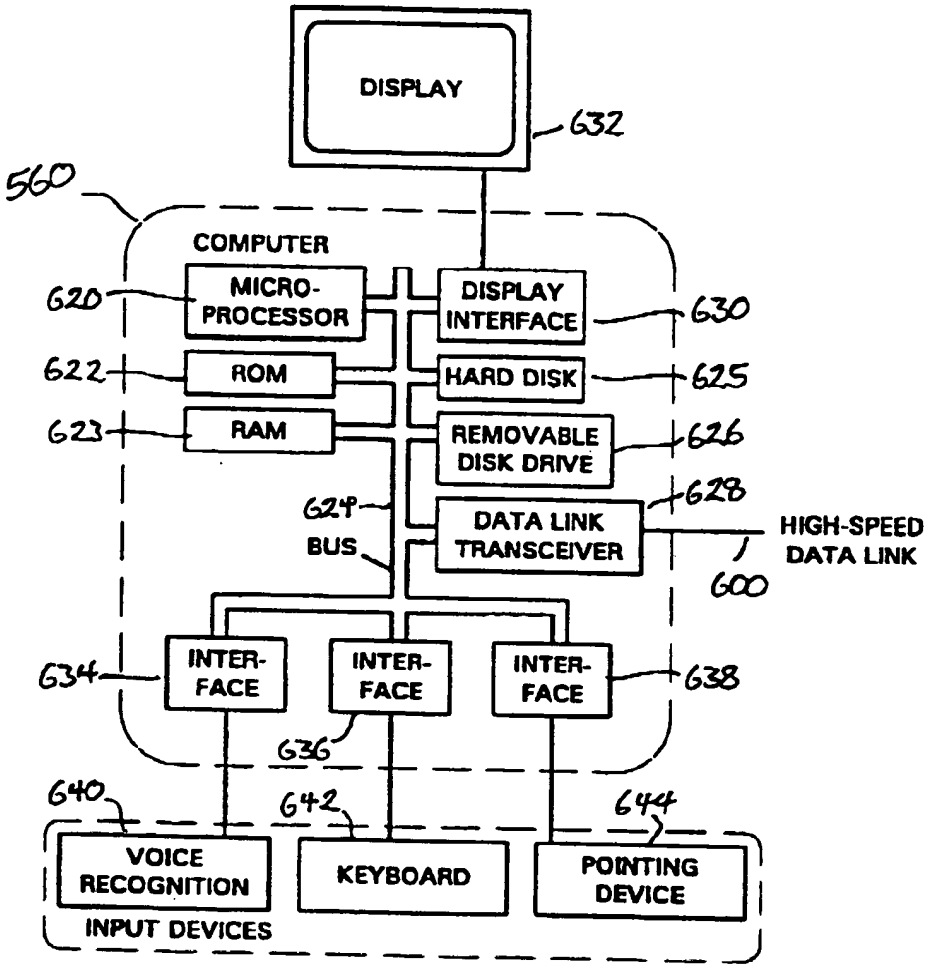

DISPLAY
632
560
COMPUTER
620
MICRO-PROCESSOR
DISPLAY INTERFACE
630
622
ROM
HARD DISK
625
623
RAM
REMOVABLE DISK DRIVE
626
628
624
BUS
DATA LINK TRANSCEIVER
HIGH-SPEED DATA LINK
600
634
INTER-FACE
INTER-FACE
INTER-FACE
638
636
640
642
644
VOICE RECOGNITION
KEYBOARD
POINTING DEVICE
INPUT DEVICES

Fig. 29

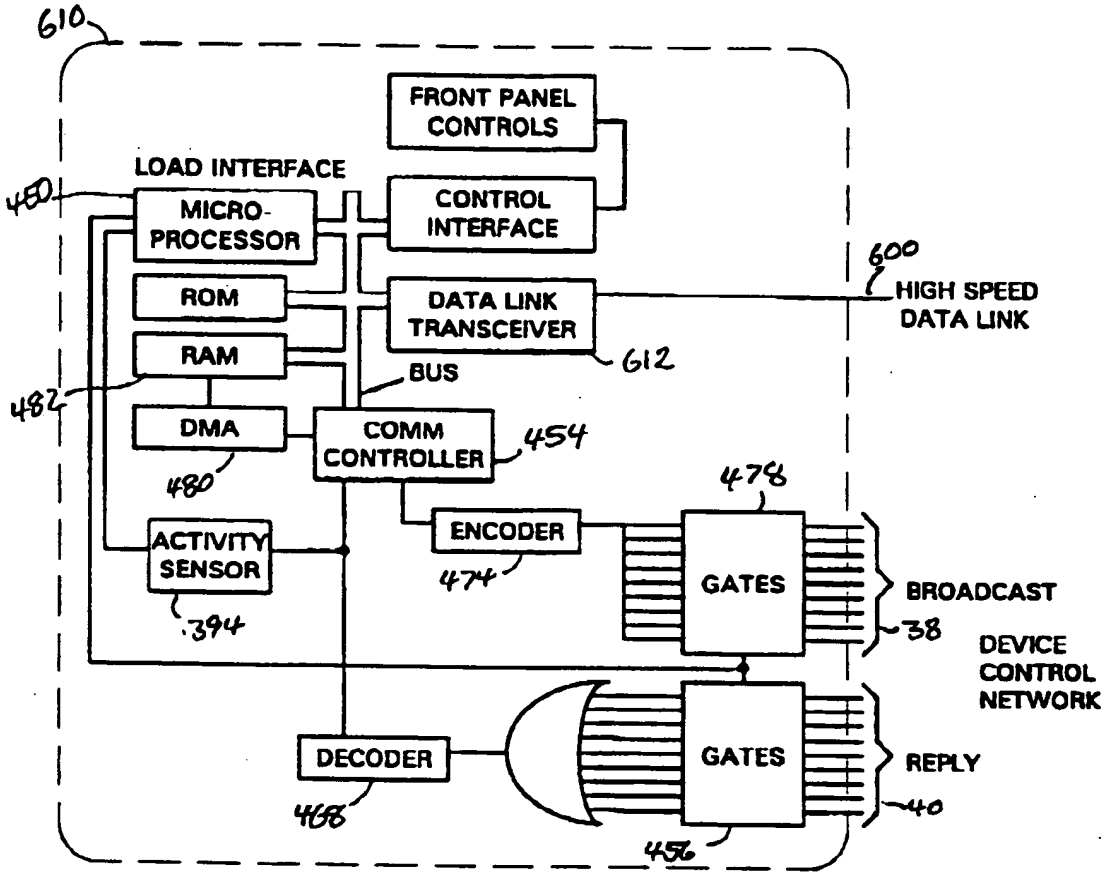

610
FRONT PANEL CONTROLS
LOAD INTERFACE
450
MICRO-PROCESSOR
CONTROL INTERFACE
600
HIGH SPEED DATA LINK
ROM
DATA LINK TRANSCEIVER
612
RAM
BUS
482
DMA
COMM CONTROLLER
454
480
478
ENCODER
ACTIVITY SENSOR
474
GATES
BROADCAST
38
394
DEVICE CONTROL NETWORK
DECODER
GATES
REPLY
468
40
456

Fig. 31

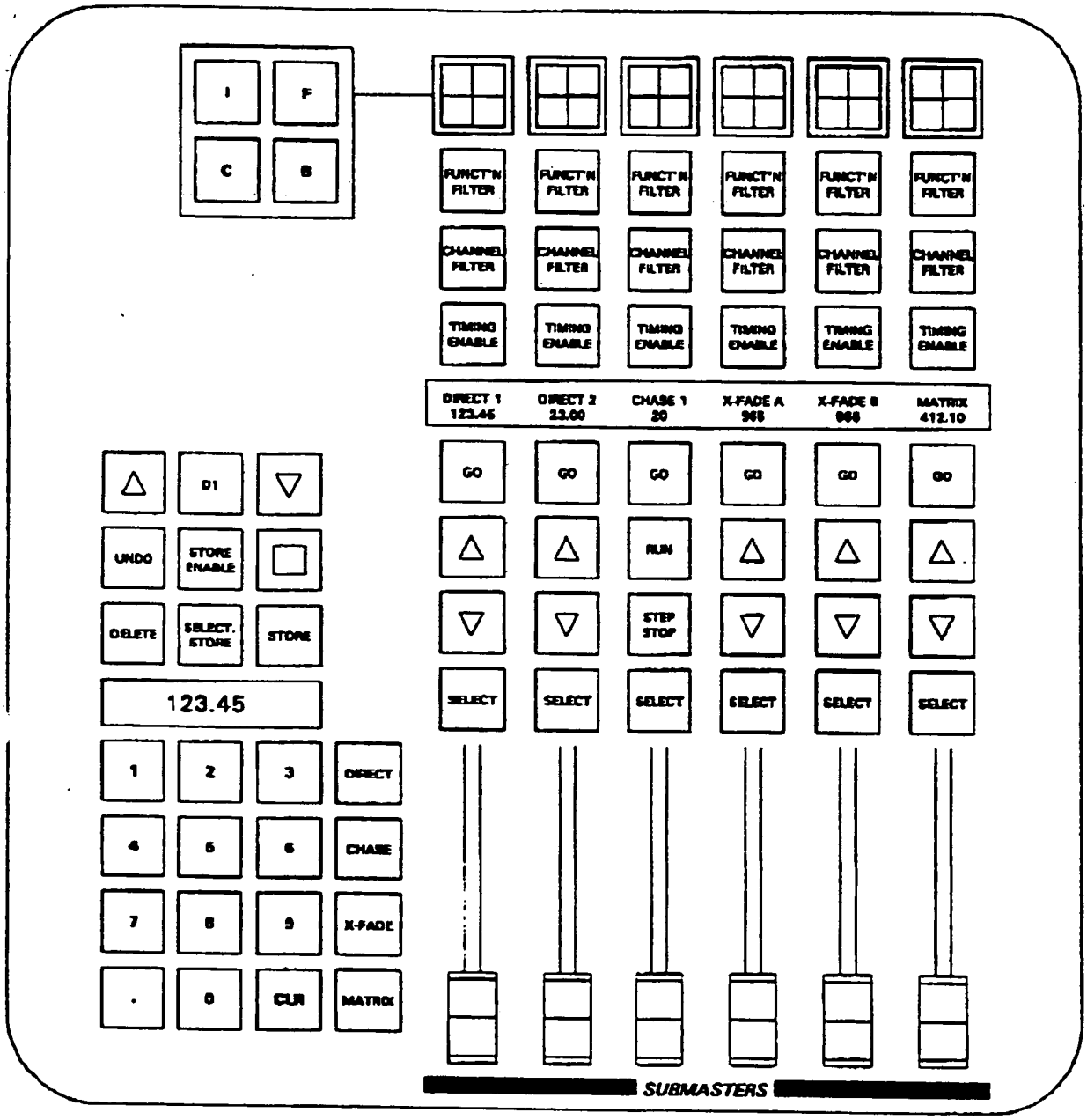

I
F
C
B
FUNCT'N FILTER
CHANNEL FILTER
TIMING ENABLE
DIRECT 1 123.45
DIRECT 2 23.00
CHASE 1 20
X-FADE A 968
X-FADE B 968
MATRIX 412.10
GO
RUN
STEP STOP
SELECT
01
UNDO
STORE ENABLE
DELETE
SELECT. STORE
STORE
123.45
1
2
3
DIRECT
4
5
6
CHASE
7
8
9
X-FADE
.
0
CLR
MATRIX
SUBMASTERS

Fig. 32

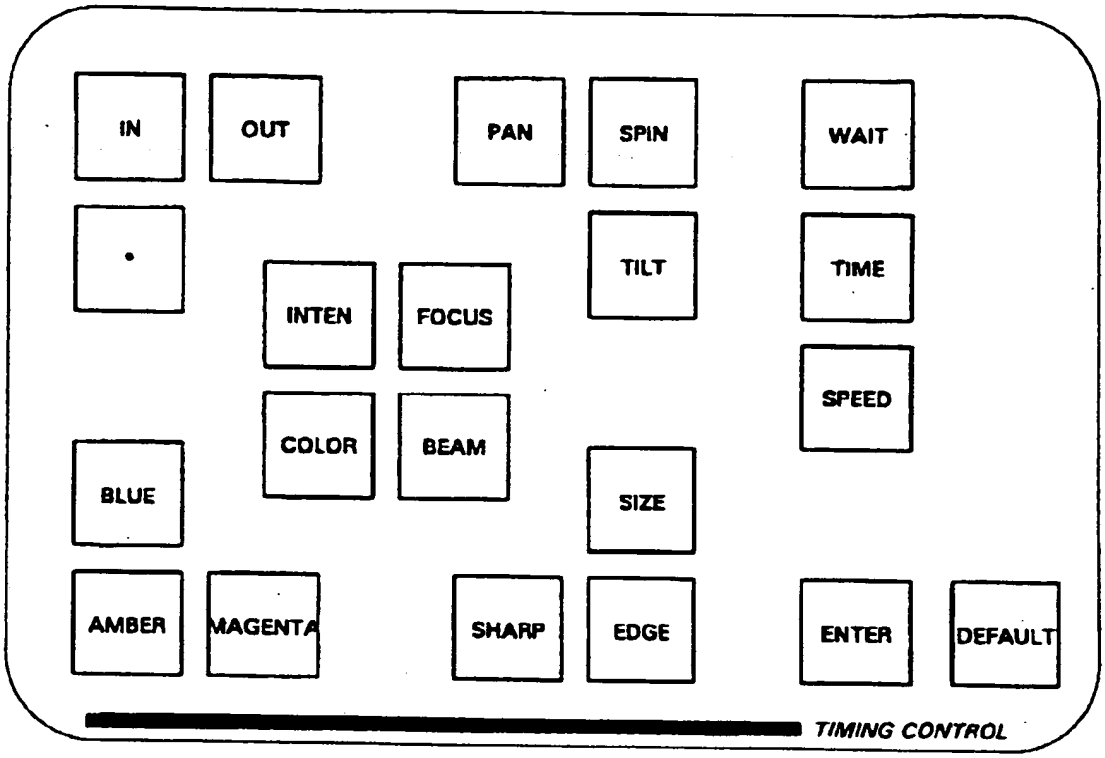

IN
OUT
PAN
SPIN
WAIT
TILT
TIME
INTEN
FOCUS
SPEED
COLOR
BEAM
BLUE
SIZE
AMBER
MAGENTA
SHARP
EDGE
ENTER
DEFAULT
TIMING CONTROL
1
2
3
4
5
6
7
8
9
0
CLR

Fig. 33

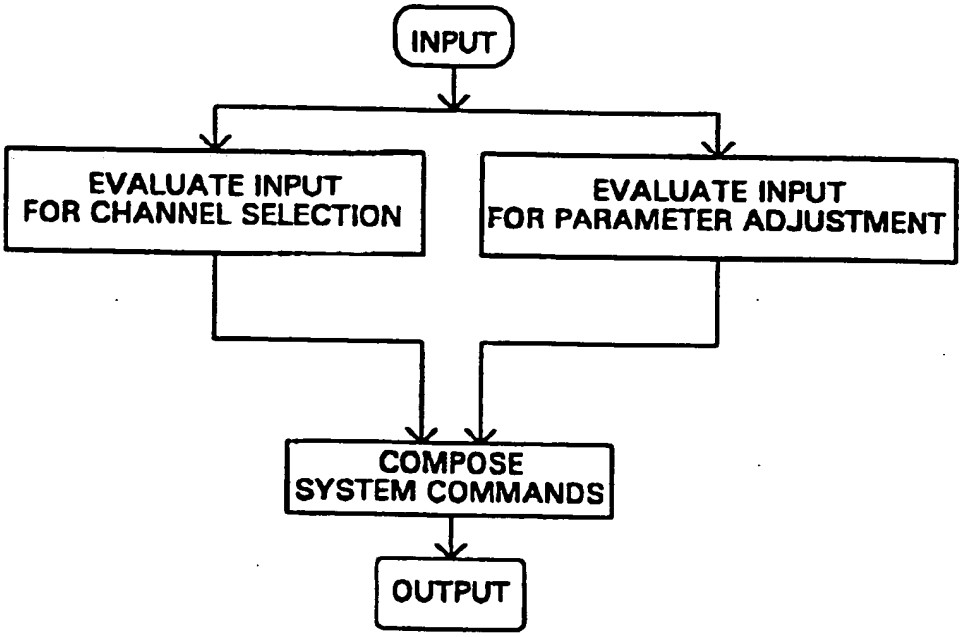

INPUT
EVALUATE INPUT FOR CHANNEL SELECTION
EVALUATE INPUT FOR PARAMETER ADJUSTMENT
COMPOSE SYSTEM COMMANDS
OUTPUT

Fig. 34